Service Science: Research and Innovations in the Service Economy

Paul P. Maglio · Cheryl A. Kieliszewski
James C. Spohrer · Kelly Lyons
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# Handbook of Service Science, Volume II

Springer

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ISSN 1865-4924 ISSN 1865-4932 (electronic)
Service Science: Research and Innovations in the Service Economy
ISBN 978-3-319-98511-4 ISBN 978-3-319-98512-1 (eBook)
https://doi.org/10.1007/978-3-319-98512-1

Library of Congress Control Number: 2010924288



This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

# Foreword by Martin Fleming

As hotel guests, we very rarely have any idea what room rate our fellow guests are paying. We quietly check in and out at the registration desk with other guests ideally knowing nothing about our transaction. Unless we are repeat visitors, we also do not actually know the quality of service to be delivered. Will the room be comfortable, have enough space, be clean? Will the hotel be quiet? Will the staff be responsive? Will the food be to our liking?

As economist Arthur Okun wrote nearly 40 years ago, this is the hotel problem (Okun 1981). Price and service quality information can only be gained through experience, though shopping can help.

The advent of hotel shopping sites, such as Orbitz, Trivago, Hotwire, and TripAdvisor, can help as travelers have the opportunity to share experiences. Similarly, online intermediate sites, such as Airbnb, can also help with room ratings available. However, across all sites, information is often incomplete. In addition, artificial intelligence capabilities allow for transaction-by-transaction price determination. There is no substitute for personal experience. There is no auctioneer calling out prices for standardized offerings.

Hoteliers, of course, understand the quandary guests face and have built successful business models to satisfy their guests. Hotels have learned to pledge certainty of offer in which service quality is consistent from visit to visit and site to site. Service quality is the focus, with client relationship management dominating business processes and employee behavior.

The expense of enticing a guest for an initial stay in turn creates high value from repeat guests and the lifetime value of the client relationship. It is ultimately the productivity, skill, engagement, and satisfaction of employees that provide the high level of customer satisfaction motivating repeat guests and delivering high profit-

ability (Heskett et al. 2008).[1] Value-added per worker, even adjusting for inflation, is high and, typically, rising at above average rates.

In contrast to standardized offerings in commodity markets, in the hotel problem, room rates are not much used to match demand and supply. Okun was a macroeconomist and was eager to show that shifts in demand are met by slowly changing prices with unit sales more rapidly absorbing adjustments. When business conditions are favorable, hoteliers are likely to forgo rate increases, for a time, as the value of obtaining new guests exceeds, over the long run, the value of an immediate rate increase. Conversely, when demand weakens, stable room rates rule out the attraction of bargain hunters in favor of building future profitable guests.

The Ritz-Carlton Hotel Company is well known for achieving high levels of customer satisfaction and building repeat business by providing employees with wide latitude and productivity-enhancing tools to meet their guests' every need. The company has for years given staff broad discretion to solve any customer complaint in the manner the employee feels is appropriate. With definitions of standards for employees to follow combined with the autonomy necessary to address client concerns quickly, the Ritz-Carlton has built consistent, sustainable business success (Inghilleri and Solomon 2010).

The hotel problem is a rich problem to have. As wealth, incomes, and standards of living have risen around the globe, services have grown to make up an increasing portion of economic activity. A wide range of service providers—travel, financial, healthcare, education, legal, technology, consulting—all face a challenge similar to the hotel problem. In the absence of known prices and quality, repeat business and customer satisfaction delivered by productive, skilled, engaged, and satisfied employees are necessary for revenue growth and profitability.

Of course, services have not always dominated economic activity. Over 250 years, the industrial era has produced 5 monumental epochs. Each epoch has been characterized by massive physical capital investment, both public and private; substantial human capital accumulation; innovative new technology, including new energy technology; shifting flows of financial capital, including a deep financial market crash; and ultimately a fundamental reconfiguration of social, political, cultural, and economic institutions and arrangements (Perez 2002).

In the early 1880s, the power loom was at the leading edge of technology. The ability to more productively manufacture textiles in volume at ever lower costs made clothing and apparel significantly less expensive. An expanded personal wardrobe was more affordable and much less of a luxury. Substantial water-powered textile factories were built in both England and New England, employing skilled and talented workers who migrated from the agriculture sector.

By the late nineteenth century, productivity in the textile industry had risen by 98% with prices falling similarly. With the completion of rail networks across North America and Western Europe, demand grew to such an extent, accompanied by

[1]Despite the current day challenges faced by service providers, service profit chain scholarship and research was largely settled 20 years ago. The classic reference is Heskett et al. (1997).

wage and employment growth, that workers learned for the first time they could leave one job and employers would competitively bid for their services in another. The emergence of the competitive labor market was a racial, social, and cultural transformation (Bessen 2015).

The global economy is now in the fifth industrial epoch. Electronics and information technology is in full deployment providing inexpensive and abundant computing and storage, allowing for radical new innovations in digital commerce, analytics, artificial intelligence, and deep learning. After the 2008–2009 financial markets crash, balance sheets have been cleansed, and renewable energy sources are taking hold; the Internet and the global telecommunications network are fundamentally altering the nature of commerce, increasing human capital requirements and redefining economic activity.

Despite the historic dominance of global manufacturing activity, the sector has faded as a source of employment in recent decades. The share of jobs in the service sector has risen in advanced economies, replacing manufacturing jobs, and in developing economies, replacing agricultural jobs. While aggregate productivity and income growth has appeared to slow as a result of the shift of capital and labor into services, the slowdown has not been uniform. The services sector is vast and consists of many subsectors with varying productivity levels and growth rates. Recent advances in technology and the global tradability of services have accelerated gains (International Monetary Fund 2018).

In the services sector, information technology has a long track record of valuation. Examples are abundant: ticketing systems for travel, supply chain management applications in retail trade, transaction processing in financial services, and patient clinical records in healthcare. The hotel industry has also extensively deployed self-service, digital reservation capabilities.[2]

In enhancing the effectiveness of services sector employees, there are three routes to improving productivity trends. First, efforts focusing on skill development and education can ameliorate sizable cross-organizational and transnational gaps. Second, trade policies that remove barriers to entry increase globally tradable services and create competitive pressures that drive enterprise transformation. Third, recent information technology developments are having meaningful impacts on services sector productivity growth and value-added creation.

Machine learning, artificial intelligence, neural networks, deep learning, and other innovations have created fundamentally new capabilities that have improved workers' ability to diagnose, decide, and act more effectively and productively.

[2]In the US hotel industry, both productivity and employment are growing. The Bureau of Labor Statistics reports productivity grew at an above average annual rate of 2.4% over the 2007–2016 period, twice the 1.2% productivity growth in the much broader nonfarm business sector. Meanwhile in 2016 at 1.882 million, industry employment was 47,700 workers above its 2007 peak and 171,600 above its 2010 low point after the 2008–2009 Great Recession.

Building on vast bodies of structured and unstructured data, such tools provide an assessment of probabilistic outcomes that allow workers to be more effective.[3]

Growth and value creation in the services sector has transformed the sector into a critical element of the global economy. Applying science to what in an earlier era might have been person-to-person courtesy is now important for economic growth. Service science as a discipline has proven to be a necessary component of the sector's maturation.

In the second volume of the *Handbook of Services Science*, Paul Maglio, Cheryl Kieliszewski, and Jim Spohrer build on the seminal work of volume one which took the first major steps in clarifying the definition, role, and future of the, then, nascent field. Now, more than 7 years later, to assess the progress toward a new interdisciplinary services science, the handbook has been expanded by collecting new chapters written by researchers and scholars who have grown up with service science, mobile phones, cloud computing, big data, and artificial intelligence.

By looking through the eyes of today's new services scientists, volume two clarifies the value and grand challenges emerging from the integration of theories, methods, and techniques outlined in the original volume. I applaud the continuing effort to build our understanding of this scientifically fascinating and economically significant area of study—the journey continues.

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[3]In addition to employee productivity tools, online shopping sites and online intermediated sites using vast stores of structured and unstructured data allow offers based on the demographics, interests, and experiences of individual consumers, creating unique room rates and moving close to the perfect price discrimination hypothesized by Okun.

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# Foreword by Irene Ng

What is simplicity? I ask this question to be provocative of course, but I do mean it seriously. It seems like the world is becoming ever more "complex"—and whenever someone says that, everyone seems to nod in violent agreement. Some great thinkers have given us much wisdom in understanding complexity, such as Senge's distinction between detail complexity, arising because of the number of variables, and dynamic complexity, arising from the way interactions create subtle causes and effects (Senge 1990). But is the world really more complex than it used to be? Or is it that our increasing understanding of the world makes it seem more complex?

The reason I start from simplicity is because I don't think you can call something complex if you can't define its opposite. You can't say "it's dark" until you can explain that "dark" is the absence of light (apologies to physicists that study dark matter). Thus, nothing is just "complex." There is an absence of simplicity. So asking "What is simplicity?" may just help us understand complexity. In a nutshell, simplicity evokes notions of atomic, unadorned, straightforward, or obvious, whereas complexity is considered to be compound, elaborate, difficult, or opaque.

My own quest for a much deeper understanding of service systems and ways to more purposefully intervene started about 10 years ago when I first moved to Cambridge—with 3 years buyout of my time to do any research I wanted to do—a mentor of mine, Professor Chris Todd from UCL (who has sadly passed away since) visited me. We had tea in a lovely cafe overlooking a great view of King's College. When he asked me what I would do in those 3 years, I presented my plans for A (4*) publications. He looked disappointed and said "Irene, you love research, and you now have time to do it. Why don't you do something hard." His comment has stayed with me since, and it has driven the research I choose to do still today.

Hard problems are inconvenient. Yet they are incredibly rewarding, and they can truly make a difference. Working on something that is complex and making it simple is a hard problem. In our quest to understand complexity, we forget that we should really be trying to understand why there may be a lack of simplicity. The larger

question of course is whether we will take the power to identify the simplicities within a complexity to enable change of a system through redesign and reengineering or whether we only wish to observe and manage complexity. Too often, I find researchers choose to be passive, as if their place in the world is merely to describe and to create understanding and insights. I am not diminishing that contribution, but I lament that we do not feel empowered to do more.

Service scientists have a lot on their plate in understanding service in a hyper-connected and complex world of science, technology, humans, cognition, and behavioral and social lives. We live in a noun-based world—engineers and scientists focusing on the artifacts, the things, the objects, the structures, and even the systems. Most people, however, create meaning from verbs—eating, seeing, reading, traveling, posting, tweeting, sleeping, and running. The combination of the two creates institutionalized rules and heuristics from a social angle; tools and data flow from the technological angle. Combining them means the combining of different approaches, methods, cultures, mindsets, skills, and training. A look across the room, a meeting of eyes, and an instant connection between two people seem too remote in concept compared to the connection between two API end points. Our natural instincts as service researchers investigating cyber-social-physical service systems are to scope it down, ignore one type of phenomenon, or change the question so that the harder questions can be put aside. Yet, there are researchers who take the opportunities to try and decipher the simple from the complex.

In thinking about systems, particularly human-centered service systems, there are natural drivers of simplicity that help us navigate the complexity to elicit simplicity. These drivers are conventions that demonstrate themselves as rules of thumb (heuristics), repetitive action (procedural memory), norms and rules (institutions), representation (models), limits (boundaries), results or conclusions (outcomes), instruments (tools and technologies), explicit expression (languages), and organized facts (information). In the world of cyber-social-physical service systems, each of these conventions are used to different degrees and in different combinations to gain either an understanding or create an improvement in how services are enabled, measured, delivered, and established within society to improve livelihoods and quality of the planet.

**Heuristics**. These are "practical methods not guaranteed to be optimal or perfect, but sufficient for the immediate goals" (Simon 1996). Heuristics are mental shortcuts. They are used when we don't wish to expend too much cognitive power; when we don't really want to think too hard. Marketing uses heuristics a lot, so that familiarity with a brand will help you make decisions to buy quickly, without searching for too much information. Common sense and rules of thumb—these are all heuristics. With heuristics, something that may be complex is perceived to be simple.

**Muscle memory**. As I type these words, procedural memory goes some way toward making us believe in the simplicity of repeated action (Gray and Lindstedt 2017; Shapiro 2010). Showing how to brush your teeth ascribes muscle-memorizing action without cognitive effort of description. Sometimes, it is simpler to show

someone how to do something, rather than explaining how to do it because when creating a pattern of action, one creates repetition, stability, and, yes, heuristics.

**Institutions**. Institutions are social norms and rules (Ostrom 2005). They generate recurring behaviors that also reinforce the norm. Eating with chopsticks and driving on one side of the road—these are rules that have been institutionalized. Driving can be complex, but if you understand and believe that the car on the other side of the road will not come over to your side of the road, you won't panic when you see a car coming toward you. Instead, you are relaxed because your actions are embedded in muscle memory and everyone generally follows the rules, making driving reasonably simple (most of the time).

**Models**. As Box's aphorism (1976) goes, "All models are wrong but some are useful." The map to guide you around the city is probably wrong too, but it is incredibly useful. Often in understanding the world, we try to be as close to reality as possible. If we do that with maps, we will never have useful maps. The simplicity of maps comes from having just enough information to guide and no more. Model making is simplifying to be useful.

**Boundaries**. The easiest way to force simplicity is to set limits (constraints). Put a man in a cage and his actions become incredibly simple. Widen his freedom to a city and you get more complexity. The point here is not that we should cage people but that we should understand why and how boundaries matter in complexity. And I don't mean merely physical boundaries, but also sociological ones like in-groups and out-groups and economic ones like transaction and payment boundaries. Boundaries drive human behavior, and putting them at the right places will change the incentives and the behavior of people within. When data was more expensive, people texted or called. When it became cheaper, they emailed and used WhatsApp. When it became cheaper still, they watched movies. Boundaries can create both simplicity and complexity. Most of all, boundaries define what is possible within a system. How high can you throw a ball? The answer is not derived from how high you have thrown it before or how good is your throwing skill. The answer is how high is the ceiling. And your behavior? If you know there is a ceiling, you won't throw as hard. Boundaries can align behaviors or destroy the workings of a system.

**Outcomes**. To create simplicity, we can define just one outcome. If the outcome of going to London is just to get to London, it's relatively simple. If it's to get to London cheaper than £30, it gets a little more complicated. If it's to get to London with a group of friends from different parts of the UK at 4 pm, it gets complex. And when one of them can't afford to go but others would like him there, it gets political. Complexity often arises when there are multiple stakeholders that want different outcomes.

**Tools**. The technological answer to human heuristics is physical tooling. The smartphone has created what economists call externalities, side effects, which may be positive or negative. Positive externalities come from better coordination between friends, better tools for productivity and efficiency. Negative externalities come from privacy loss and addiction. Human lives are made simpler with tools. Scheduling meetings is simpler with doodle; coordination is simpler with WhatsApp.

**Language**. Simplicity is created often with an explicit language, like mathematics or music. Such "languages" have very little ambiguity, which is why mathematics is used for models and music is a representation of the emotions of the creator (Cooke 1959/1989). Other human languages have modalities, that is, they are like signs and they reflect a status of reality that requires interpretation by others. The more words we have for sad or happy, the richer our descriptions become—but also the more complex. Words are performative in that they can be self-fulfilling, and using words changes us and changes others. Using words, whether to describe complexity or to create simplicity, immediately creates a description that is value laden.

**Information**. Information can create simplicity. When I go to London, I know where I am going. A third party observing my movements and predicting where I go next will find my decisions and movements hard to understand and may deem them "complex." For me, even if I deviate along the route, I know why I deviated and what I will do next. My actions are not complex to me at all. Simplicity is therefore a matter of information and perspective. Information and heuristics combine to create templates of behaviors around the goods and services we buy and use. They make the world simple to us, though it may be complex to observers. The question to ask as researchers is whether a system is truly complex or whether we simply do not understand it or know it, making a judgment that it is complex. Together with information come the four types of information drivers of simplicity and complexity: asymmetry (something I know but you don't), incomplete (something that is not known now), uncertain (we're not sure if the information is true or false), and ambiguous (there are two meanings, but we don't know which one is the right one). Together with assumptions of human rationality, we take a stand on how we view a system. Most economists like to use perfect rationality with symmetric, complete, certain, and unambiguous information in their models. The reason for this is to create models that establish the "height of the ceiling." It is the boundary that helps us understand all human behavior that would lie within and below it. It isn't important that such a model may not exist. They can serve as a boundary guide. Like stars in our solar system, we may not be able to travel to them, but they are incredibly useful for navigation.

Service science is a discipline of service to humanity. The work captured in this second volume of the *Handbook of Service Science* embraces the challenge of doing something hard. My hope is that researchers and practitioners in this field continue to take up the baton and meet that challenge through understanding complexity from simplicity and remain empowered to change systems through redesign and reengineering. You should do something hard too.

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# Preface

We didn't plan to compile a second volume of the *Handbook of Service Science* 10 years ago when we started to compile the first one. We didn't know where the field of service science would be or, frankly, whether there would be a field at all. But a few years ago, we were deeply gratified to learn that the *Handbook* was in wide use and considered an important reference. Yet, as we all know, things change, and we started to ask colleagues to think about the progress that had been made in the study of service. We asked them—and we asked ourselves—where is service science today?

After all, the world has changed significantly in 10 years. Advancing technologies—smartphones, cloud computing, social platforms, big data analytics, artificial intelligence—have transformed business models and are reshaping public policy, from retail and hospitality to transportation and communications. The first volume of the *Handbook* marked the emergence of the field of service science: integrating established disciplinary studies of business-to-customer service systems with the needs of a new era of business-to-business and societal scale service ecosystems (the so-called Smarter Planet era). Nevertheless, most chapters in that volume focused on one aspect of service from a single disciplinary perspective. We decided to expand the *Handbook* by collecting a new set of chapters for *Volume II*, written mainly by researchers and academics who have grown up with service science. We thought that by looking through the eyes of today's new service scientists, we might begin to see value and grand challenges emerging from the integration of theories, methods, and techniques brought together in the original volume. Now, in this volume, we see some familiar themes but rooted more deeply in service-dominant logic and systems thinking. We see needed clarity in how to identify, enable, and measure service, and we see new ideas and connections made to physics, design, computer science, and data science and analytics for advancing service innovation and the welfare of society.

We thank Martin Fleming and Irene Ng, who each generously provided forewords to the volume, providing considerable insight into some of the challenges and opportunities facing service research. Martin tells us "the global economy is in the

fifth industrial epoch," in which current technologies are enabling radical new innovation that will have a direct impact on the growth and importance of service. Irene tells us that "hard problems are terribly inconvenient," yet they are everywhere in service. Luckily, many smart and talented people are ready to suffer this inconvenience to shed light on otherwise often complex and opaque problems and situations. Chapters in the first volume represent seminal thinking about the scientific study of service, service systems, and service innovation. They helped spur conversations across fields and establish a common language for talking about service. Chapters in *Volume II* represent a snapshot of where we are today: to a large extent mixing methods and disciplines, working from a common vocabulary, and going beyond simple characterizations of service to understand, design, and influence aspects of the global service system in all of its complexity.

We also thank everyone else who helped bring together this collection of work: our associate editors, Kelly Lyons, Lia Patrício, and Yuriko Sawatani, who solicited chapters and shepherded the review process, working with authors and reviewers to develop a set of truly exciting papers; Melissa Fearon and Carolyn Flanagan at Springer who encouraged us and established a smooth production process; and of course, our contributors, whose extraordinary work we are lucky to showcase here.

Where will service science be 10 years from now? Let's find out!

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San Jose, CA, USA — Cheryl A. Kieliszewski
San Jose, CA, USA — James C. Spohrer
Toronto, ON, Canada — Kelly Lyons
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# Chapter 1
# Introduction: Why Another Handbook?

**Paul P. Maglio, Cheryl A. Kieliszewski, James C. Spohrer, Kelly Lyons, Lia Patrício, and Yuriko Sawatani**

**Abstract** Advancing technologies, including smartphones, cloud, social platforms, big data analytics, artificial intelligence, and more have begun to transform business models and public policy. These changes are being reflected in the evolving discipline of service science. The chapters collected here are drawn from both newly minted researchers who have grown-up with service science, and established researchers who are adapting their frames for the modern service context. They represent a variety of perspectives on the emergence of a new science of service and are sure to become required reading for today's service scientists.

**Keywords** Service science · Service systems · Service thinking

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_1

Why another *Handbook of Service Science*? We can answer that question with a question: What does a service scientist need to know *today*? The first *Handbook*, published in 2010, marked the emergence of the new field of service science. At that time, disciplinary studies of business-to-customer service systems began to intertwine to meet the needs of a new era of business-to-business and global service ecosystems. Today, advancing technologies (e.g., smartphones, cloud, social platforms, big data analytics, artificial intelligence, etc.) have begun to transform business models and public policy, and these changes are being reflected in the evolving discipline of service science. Much has changed and much has been learned since the original volume of the *Handbook*. The work collected here is drawn from both newly minted researchers who have grown-up with service science, and established researchers who are adapting their frames for the modern service context. The chapters represent a variety of perspectives on the emergence of a new science of service and are required reading for today's service scientists.

## 1.1 The Basics of Service Science: Then and Now

Hill (1977) defined service as "a change in the condition of a person, or of a good belonging to some economic unit, which is brought about as the result of the activity of some other economic unit, with the prior agreement of the former person or economic unit" (p. 318). Vargo and Lusch (2004) defined service as "the application of competence for the benefit of [others]" (p. 14). These definitions emphasize different things: Hill's emphasizes agency, action, and change, and Vargo and Lusch's emphasizes expertise, capabilities, and benefits. Together, these helped us define service as "value cocreation," useful change that results from purposeful action and communication between individuals and organizations (Maglio et al. 2010; Maglio and Spohrer 2013; Maglio and Kieliszewski 2015). Key constructs in service science include the service system and service-dominant logic (Maglio and Spohrer 2008; Maglio et al. 2009; Spohrer and Maglio 2010; Vargo and Lusch 2004), with theories and methods drawn from a variety of related fields, including marketing, operations, optimization, strategy, computer science, psychology, and more (see also Spohrer and Maglio 2010). Simply put, service science combines organization and human understanding with business and technology understanding to explain and design service systems. Busting silos along the way.

Service-dominant logic provides perspective and vocabulary to build a theory upon; and service systems, as dynamic configurations of resources, provide a basis for modeling interactions among entities. Core principles of service science center on how value is computed among entities, how interaction depends on access to resources and capabilities, and on how value-computation depends on symbolic processing and language in the context of mutually agreed upon value propositions (Maglio and Spohrer 2013). Value results when interactions among entities leave the entities better off, such as better fit to their environments or greater resilience to adapt to changing circumstances, than they were before the interactions (Vargo et al.

2008). Some interactions can be more effective than others in creating value, and therefore some arrangements of resources can be better than others at setting-up a system for effective value cocreation. Computational modeling can be very useful in capturing interactions, dependencies, and dynamics among entities in a service system to evaluate the effectiveness of resource arrangement in complex systems (e.g., Qiu 2009; Park et al. 2012; Kieliszewski et al. 2012). Understanding the emergence of service ecosystems from the interactions of primitive actors is an important area for simulation studies of the service sector (Fujita et al. 2018). Yet interaction among actors is not the sole mechanism of service improvement and innovation.

Service innovation results from the reconfiguration of roles and responsibilities in a system of interacting entities (Normann and Ramirez 1993). Economic scholars who study advancing technologies foresee a transition from a production stage to a distribution stage in the economy, as technologies advance, and people in service systems adapt (Arthur 2017). Today, technological advances increasingly drive such reconfigurations more and more. For instance, with technologies becoming smarter or autonomous, data- and algorithm-driven decision-making can occur without human control (see also Larson 2016; Maglio 2017a, b; Medina-Borja 2015). Service and service science are fundamentally concerned with people and their role in value creation across individuals and organizational boundaries (Maglio et al. 2015). But what happens when actors in service systems are machines, taking deliberate action on their own, making effective changes but without direction or control of people? Both automating and augmenting human intelligence are creating the need for new policies and laws; autonomous systems are on the horizon, and solutions to artificial intelligence challenges seem nearer than ever (Rouse and Spohrer 2018).

## 1.2 The Evolution of Service Science and the Evolution of the *Handbook*

Service science has expanded over time across disciplinary areas, including service marketing, information systems, operations, and design, both influencing these areas and being influenced by them (Ostrom et al. 2010, 2015; Maglio et al. 2015; Peters et al. 2016). The multidisciplinary nature and evolution of service science is evident in this volume, with chapters coming from scholars in many different disciplines and touching on themes across disciplines. For instance, Alexandra Medina-Borja connects engineering, operations research, social sciences, and computational sciences; Michael Dixon and Liana Victorino connect behavioral sciences and operations; Cheryl Kieliszewski and Laura Anderson connect anthropology and data science; and Scott Sampson connects operations and design.

Technologies have changed the service environment over time as well. Whereas smart services, the sharing economy, and artificial intelligence were once promising

areas, they are now having a more substantial impact on service environments (Breidbach and Brodie 2017; Rouse and Spohrer 2018). This technological evolution creates substantial changes in service environments, raising challenges and opportunities for service science. In this volume, for instance, Christoph Breidbach, Michael Davern, Graeme Shanks, and Ida Asadi-Someh consider the ethical implications of big data analytics in service contexts; Amy Ostrom, Darima Fotheringham, and Mary Jo Bitner describe the future of frontline service in the context of modern artificial intelligence capabilities; Robin Qiu, Tianhai Zu, Ying Qian, Lawrence Qiu, and Youakim Badr examine the role of big data and the Internet of Things across a variety of service contexts; and William Rouse, Kara Pepe, and Michael Johns discuss technology-enabled integration of services across society-scale systems.

In the end, we see some conceptual changes in the evolution of service science from the first volume to the second. Today, there are clear emphases on the human-side of service systems, the more complex and networked nature of the service experience, and the broader scope of service ecosystem—little of which was evident 10 years ago. And this is reflected in the organization of the volumes. The first volume was structured around (1) history and theory, (2) practical and disciplinary areas of design, operations, delivery, and innovation, and (3) forward-looking issues and challenges. The current volume is structured around (1) human experience in service, (2) system interactions in service, (3) the broad context of service, and (4) theoretical innovations and challenges in understanding and improving service. We no longer see the need to structure the volume around historical concepts and disciplinary silos; service science has evolved as the result of cross-pollination of ideas and methods from different areas and from the use of technology in modern service practice (Maglio 2017a, b; Maglio and Breidbach 2014). Progress is tied to a deeper understanding of the nature of value creation, which necessarily involves people (e.g., Storbacka et al. 2016; Vargo and Lusch 2016), whether in small contexts or large (e.g., Barile et al. 2016; Vargo and Akaka 2012), whether supported by technology or not (e.g. Lusch and Nambisan 2015; Vargo et al. 2015), or whether in deliberately designed settings or in ones that evolve over time (e.g., Maglio and Spohrer 2013; Patrício et al. 2011). Progress is tied to tools and techniques, to new methods for modeling and analysis, for instance, tied to real time data about customers and operations in large-scale systems (e.g., Rust and Huang 2014). These conceptual changes follow years of experimentation and practice in real service settings, with scientists, engineers, and practitioners armed with initial concepts and tools from the emerging service science.

## 1.3 Structure of the Book

More precisely, this volume is organized in four parts, each representing a variety of disciplinary perspectives on some aspect of service. The structure emerged based on the experiences and perspectives of the volume's contributors. Some chapters are

concerned with the service experience; others, with the system of interactions that comprise specific service offerings; others still, with the broad business and environmental ecosystems in which service happens; and finally, some are concerned with the theory and challenges of understanding service and service systems. We next describe briefly each of the four parts and the chapters in them.

*Service Experience: On the Human-Centered Nature of Service*. Service and service science are fundamentally concerned with people and their role in value creation across individuals and organizational boundaries (Maglio et al. 2015). The volume begins with a number of chapters related to the role of people and of human experience in service. In Chap. 2, Bolton recognizes that service timing, though critically important to customer engagement in dynamic environments, is understudied by service researchers, and shows how new data sets can provide exciting opportunities to advance our knowledge of the service experience. In Chap. 3 Dasu and Brunner-Sperdin identify factors that influence the customer's role in decision making, particularly how trust influences the desire for decision control. In Chap. 4, Dixon and Victorino provide a comprehensive literature review of behavioral sciences research related to service scheduling—how customers respond to temporal decisions about the beginning, middle, end, and duration of service experiences. In Chap. 5, Ostrom, Darima, Fotheringham, and Bitner take a customer-centric view of narrow artificial intelligence (AI) in the context of frontline service encounters to develop a revised conceptual framework of technology adoption and service innovation, incorporating factors of trust, privacy, and "creepiness". In Chap. 6, Roels emphasizes the competitive advantage available to firms who reliably deliver memorable customer experiences, and provides design guidelines for such experiences. In Chap. 7, Sangiori, Lima, Patrício, Prestes Joly, and Favini provide a perspective on service design as a human-centered, multidisciplinary effort that drives service innovation and service system transformation. In Chap. 8, Sawatani examines the expansion of design research and impact of service research, service design, and management research upon the field. In Chap. 9, Strong and Verma apply service science and service design principles to the patient experience in healthcare, particularly in the context of health information technology. In Chap. 10, Zaki and Neely discuss the role of new technologies in creating novel customer experiences as a strategic priority of firms, including many touchpoints and data explosion.

*Service Systems: On the Nature of Service Interactions*. From the start, the service system has been viewed as a basic abstraction in the study of service (Maglio and Spohrer 2008; Maglio et al. 2009). Today, the service system is alive and well, still providing the conceptual framework for many studies. In Chap. 11, Chandler examines service systems, synergetics, and multi-sided platforms from the perspective of future service systems, and multi-level (micro, meso, and macro) service systems evolution. In Chap. 12, Feldman, Fromm, Satzger, and Schüritz examine involvement of employees in service innovation processes and explore the benefits of collective intelligence. In Chap. 13, Frost, Cheng, and Lyons present a comprehensive approach to modeling service systems that incorporates a typology of service system entities, interactions, and more. In Chap. 14, Kieliszewski and

Anderson explore enterprise-scale service innovation across heterogeneous boundaries using a novel digital trace data analysis framework that integrates cultural-historical activity theory, activity system analysis, and diverse data sources. In Chap. 15, An, Machra, Moser, Simonovikj, and Larson provide a wide range of examples of queues in service systems, and demonstrates that while they show-up in unusual places, they are no match for a rigorous (and often fun) mathematical analysis. In Chap. 16, Lim and Maglio clarify the concept of smart service systems, using the technique of analyzing texts from the scientific literature, news articles, and end-user opinions. In Chap. 17, Martinez, Neely, Velu, Leinster-Evans, and Bisessar explore the service journeys of firms as they implement their servitization or service transition in strategic stages. In Chap. 18, Piciocchi, Bassano, Pietronudo, and Spohrer rethink the role of service workers, particularly in the context of digital technologies in the age of artificial intelligence. In Chap. 19, Sampson introduces Process-Control Network analysis as a service system design tool.

*Service Ecosystems: On the Broad Context of Service*. Beyond the narrow service system in which individuals and organizations engage in service interactions for mutual benefit, there has been a recent move to consider the broader context of ecosystems of service in which networks of suppliers, partners, and other stakeholders engage (Lusch et al. 2016). The ecosystem perspective highlights the role of institutions and institutional arrangements in value creation (Vargo and Lusch 2016; Spohrer et al. 2012). In Chap. 20, Akaka and Parry draw upon a service-ecosystem view and identify dimensions of value-in-context that shape evaluations of experience, advancing our understanding of processes of valuing in service science as value computation. In Chap. 21, Basole rethinks service ecosystems, shifting beyond linear service value chains, or even inter-connected industrial service networks with service-level agreements (SLAs), towards digitally mediated relationships on platforms defined by an emerging application programming interface (API) economy. In Chap. 22, Jaakkola, Aarikka-Stenroos, and Ritala go to the heart of better value co-creation as a process of institutionalization. In Chap. 23, Mele and Russo-Spena offer an integrated view of human systems and technical systems by describing the results of a practice-based study of service provision and innovation in the healthcare ecosystem through wearable devices. In Chap. 24, Pavlov and Hoy apply the service science framework to higher education, demonstrating the utility of a novel "service science canvas." In Chap. 25, Qiu, Zu, Qian, Qiu, and Badr examine the relationship between service science and Internet of Things (IoT) in the context of using the big data available from smart cities, mobile devices, and digital platforms. In Chap. 26, Rouse, Pepe, and Johns use the example of substance abuse to introduce population studies and demonstrate the interconnectedness of health, education, and social services systems. In Chap. 27, Samuelsson, Witell, Gottfridsson, and Elg conceptualize incremental and radical service innovations and their diffusion processes with health care examples.

*Challenges: On Rethinking the Theory and Foundations of Service Science*. Despite some clear trends in the development of concepts, theories, and methods in service science, much remains to be done and much remains in question (see also Ostrom

et al. 2015). In the final part of the volume, we collected chapters that rethink or question some of the assumptions of this emerging discipline. In Chap. 28, Akaka, Koskela-Huotari, and Vargo further evolve service-dominant logic as the foundation for service science, including five core axioms, the role of institutions in value co-creation, and service innovation. In Chap. 29, Breidbach, Davern, Shanks, and Asadi-Someh remind us of the potential ethical implications of big data analytics for those who use big data to generate new value propositions or for value cocreation. In Chap. 30, Cantone, Testa, and Marrone challenge the premature "black-boxization" and iconic status of service-dominant logic in service science. In Chap. 31, Desmarchelier unites production and innovation in a view of service as catalyst of innovation, the result of "actors who increasingly complexify the economic system." In Chap. 32, McColl-Kennedy describes capstone events and disciplinary outcomes from the launch of service science to the present. In Chap. 33, Medina-Borja provides a summary of the past, present, and possible future of mathematical modeling of services systems with the goal of improving human-machine cooperation. In Chap. 34, Polese, Barile, Loia, and Carrubbo use a bibliometric analysis to argue that the service science community remains locked in disciplinary siloes. In Chap. 35, Wirtz and Ehret present the challenges of building competitive advantage to capture value in the service economy, identifying three types of assets that play a major role. In Chap. 36, Yamauchi uses ethnomethodology to turn the concept of service on its head, examining customer satisfaction as "intersubjective struggle".

When we put together the original *Handbook*, we did not know whether we would still be talking about service science 10 years later. We did not know whether the frameworks, theories, methods, and findings would hold up. We did not know whether we would still be thinking about service the same way. We did not know whether we would still be service scientists. But here and now, we see some familiar ideas and concepts in this *Handbook of Service Science, Volume II*. We also see the results of deep investigation and vigorous debate, and the evolution of familiar concepts—some more entrenched, others challenged—along with newly identified and truly unforeseen concepts from when we had compiled the original volume nearly 10 years ago. Service science has lasted, and it has improved. It is still an exciting time to be a service scientist.

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# Part I
# Service Experience – On the Human-Centered Nature of Service

# Chapter 2
# Service Timing: Designing and Executing Service in a Dynamic Environment

**Ruth N. Bolton**

**Abstract** Service managers and researchers have long recognized that service timing is critical. Studies of how waiting time and reliability are important to customers and service firms began more than 50 years ago. Current research explores how customer engagement, co-production and co-creation unfold over time. This article reviews prior research and models of the dynamics of service timing that have emerged. It argues that service timing and its nuances are neglected by managers and researchers. Notably, customer service experiences are often embedded in rich social and emotional contexts, mediated by technology, and evolving across different service channels, platforms and locations over time in ways that are not well understood. Fortunately, rich individual-level business-to-customer and customer-to-customer data offer exciting opportunities to advance our knowledge of the dynamics of service experiences. This chapter reviews what is known (and unknown) about service timing and suggest specific research questions, opportunities and challenges.

**Keywords** Service design · Service innovation · Service operations · Customer experience · Service experience · Customer relationships · Service encounters · Dynamic models

## 2.1 Service Timing Is Critical

Recently, service managers and researchers have emphasized the importance of the customer journey with a firm, defined as the customer experience over time and across touchpoints (Lemon and Verhoef 2016). This perspective has focused attention on how customer experiences unfold over *time*—that is, on the dynamic nature

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_2

of the customer experience and journey. Yet, it is easy to argue that the core of service science has always focused on customers' experiences over time. A vast stream of research across multiple disciplines considers service quality as arising from three underlying processes—the quality production process, the quality experience process, and the quality evaluation process (Golder et al. 2012). For example, waiting time is fundamental to how service operations are managed (e.g., Aksin et al. 2007) and reliability or consistency over time is considered to be a major ingredient in customers' perceptions of service quality (e.g., Brady and Cronin 2001). Why then, after more than 50 years of research (Jacoby et al. 1976), are service managers and researchers emphasizing (yet again) the importance of understanding how service experiences unfold over time?

One important reason for a renewed interest in service timing is that firms have vastly greater capabilities to interact with customers over time in the modern business environment when compared with the past. Due to advances in technology, customers and firms interact at multiple service touchpoints, as well as via digital and social media platforms. These customer-firm interactions can take place at different locations and times, as well as when the customer is mobile and using a smart device. Moreover, the internet of things (IoT) has led to "smart products" that deliver localized, real-time services. The popular business press is replete with reports of novel services: people managing services in their smart homes; robots that replace self-service kiosks in restaurants and health workers in nursing homes; field service representatives who rely on information from sensors embedded in on-site equipment; and healthcare advances that leverage analytics and smart medical devices.

Service timing has renewed importance because, with this bewildering array of new opportunities, how will firms "connect the dots" to create service experiences that unfold over time in ways that are meaningful and valuable to customers?

### *2.1.1 Some Questions About Service Timing*

In this exciting new business environment, service science is wrestling with many new challenges. A few examples:

1. How can firms deliver on the promise of service personalization? Despite improvements in leveraging pertinent information about customers, firms' ability to deliver relevant products and services to consumers is still a promise—not a reality. These challenges are especially great when customers are using mobile devices.
2. How can firms create a seamless service experience that is consistent over time and across channels—and authentic? There is an increased prevalence of RFID tags, smart appliances, wearables and the promise of a "network of devices," but firms are typically managing discrete service encounters (i.e., isolated interactions), not holistic experiences that match customer needs.

3. How can firms leverage two-way communications to collaborate in the creation of customized service experiences for their customers? Firms seek "customer engagement"—that is, interactions that are not purchases that deepen customer-firm relationships—and they are communicating with customers in many ways (Van Doorn et al. 2010). For example, firms can provide active recommendation systems that explicitly obtain inputs from customers. However, most communications are one-way not two-way—and they seldom leverage the history of the customer-firm relationship.
4. How can firms better utilize geo-targeting (via GPS) to reach the right customer at the right time and place? Mobile devices (smart phones, wearables etc.) allow firms to interact with customers anywhere at any time. Thus, firms' management of service timing implies a capability to reach the customer at the right place, as well.

### 2.1.2 Are We in Danger of Over-Simplifying?

There is a very great danger that managers will tackle tomorrow's service challenges with yesterday's tools. When we examine how firms have usually designed and implemented service, any consideration of timing is noticeably absent. Certainly, service companies usually attempt to deliver fast and responsive service (Bolton and Drew 1992.) However, these efforts do not improve the consistency of service for the individual customer. For example, quality improvement tools, such as the "six sigma" approach to reducing service defects or failures, typically analyze cross-sectional data rather than data that reflect an individual customers' experience over time (e.g., Antony 2006). This approach identifies certainly identifies out-of-control service processes—but it fails to consider the process from the viewpoint of the individual customer at a particular point in time.

New technology has brought a harvest of "big data," but (sadly) the data pool is often a mile wide and an inch deep. Service managers and researchers need "deep data"—a fusion of relevant longitudinal data from many sources—to understand and improve customer experiences (Kramer et al. 2004).

### 2.1.3 What We Know: Timing Matters

Our lack of knowledge about service timing is rather surprising given that thought leaders have defined service experiences as *process*-based consumption over time, not outcome-based consumption. For example, Grönroos (1998, p. 322) emphasizes that "A central part of service marketing is based on the fact that the consumption of a service is process consumption rather than outcome consumption." Empirical work has reinforced the point. For example, studies have shown that, when customers experience repeated service failures ("double deviations"), they are more likely to

attribute blame to the firm and its recovery efforts are less likely to be effective (Maxham and Netemeyer 2002). In contrast, repeated favorable service encounters increases the likelihood that a customer will repurchase from a service firm (Bolton et al. 2006).

The preceding discussion highlights how customers' evaluate service experiences holistically, rather than judging discrete service encounters. It also implies that customers take a longitudinal perspective with chronological order, rather than a considering a "service snapshot" at one point in time that ignores path dependencies. For this reason, service timing must inevitably take into account all dimensions of customer-firm relationships.

In both the service management and customer relationship management literature, theoretical and empirical work has shown that managing variability over time in individual customers' service consumption increases their satisfaction, loyalty and cross-buying (e.g., Bolton and Lemon 1999; LaBarbera and Mazursky 1983). Recent research has gone a step further and shown that strategies which decrease variability in service consumption processes also improves firms' overall financial performance (Tarasi et al. 2011, 2013). Empirical support for these findings has been demonstrated across three settings: telecommunications, financial and logistics services. Moreover, these strategies are demonstrably actionable by most service managers. For example, improving consistency in service increases a firm's customer satisfaction levels, increases its cash flow levels and decreases risk.

### *2.1.4 What We Don't Know: How to Manage Service Over Time*

Over many decades, service science has made considerable progress in understanding how customer experiences unfold over time, especially how customer attitudes and behavior change (e.g., Bolton and Drew 1991; Bolton 1998). However, using this knowledge to manage service timing is challenging. To understand the managerial challenges, it is useful to consider a few illustrations of what is known about the important role of time in designing and executing superior service experiences for customers.

- Customers perceive improvements in service performance, but their overall perceptions of service quality are stable and change slowly over the long run (Bolton and Drew 1991).
- Customers have a confirmatory bias—that is, their perceptions of service quality are influenced by their prior expectations—thereby creating a "double whammy" effect on service quality (Boulding et al. 1999). This phenomenon may be one reason why a service firm's reputation or brand equity is a source of competitive advantage.
- The chronological order of service encounters influences customers overall evaluations of their experiences. Customers prefer a happy ending—that is, a

negative event followed by a positive event—rather than the reverse (Ross and Simonson 1991).

- Customers prefer service brands that are "pioneers" (i.e., first-to-market) as well as service brands that they experience first—especially when service attributes are alignable (Carpenter and Nakamoto 1989; Niedrich and Swain 2003).

Researchers have begun to consider more complex scenarios, but their work is still at the conceptual stage (e.g., Sivakumar et al. 2014).

These findings are useful *if we assume that firms manage the timing of service encounters*, so that they can control when and how customers acquire information and learn (through experience) about service offerings. Unfortunately, this assumption is often unrealistic—especially in today's technology-infused marketplace. Customers are active co-creators of the value derived from service experiences, and their active participation has important implications for service timing.

## 2.2 Service as a Dynamic Process: Co-created Over Time

To understand service timing, service scientists must start from a value co-creation perspective. Lusch and Vargo (2006, p. 284) argue that "value can only be created with and determined by the user in the 'consumption' process and through use or what is referred to as value-in-use." Co-creation "involves the [customer's] participation in the creation of the core offering itself. It can occur through shared inventiveness, co-design, or shared production of related goods, and can occur with customers and any other partners in the value network." From this perspective, the firm does *not* design and deliver service to customers at one or more specific points in time. Rather, customers co-create value with the firm through many interactions over time—where both customers and firms are a 'source of competence' (Prahalad and Ramaswamy 2000, 2004). Customers and service providers are dynamically adjusting their behavior as the service experience evolves.

Customers engage in spontaneous, discretionary behaviors over time that uniquely customize the service experience. The nature and extent of their participation is influenced by their goals, role clarity and capabilities (Bolton and Saxena-Iyer 2009). In a business-to-business (B2B) context, value co-creation might entail customer and supplier teams jointly designing and executing high technology, interactive services over a period of many years. In a business-to-consumer context (B2C), value co-creation might entail a patient and his/her medical team developing and executing a treatment plan that improves his/her health. As these examples illustrate, the customer often plays a proactive role in the design and execution of the service experience over time—interacting with the firm's employees, technology and other aspects of the servicescape.

Since customers interact with the firm's technology, people and processes in the creation and delivery of services, customer participation and co-creation directly influences service processes, customer outcomes (e.g., service quality and service

usage levels) and firm outcomes (efficiency, effectiveness, revenues and profits). Consequently, effective service timing is necessary to create value for customers and firms.

### *2.2.1 What Happens When the Customer Is In Charge?*

Customers co-create value to achieve their goals. Their appraisal of the means to achieve a goal requires the integration of their expectations, beliefs and perceptions (Bagozzi and Dholakia 1999). Conscious goals influence attentional mechanisms and how customers interpret cues during service encounters (Tarasi et al. 2017). A customer assesses his/her progress towards a goal and then adjusts his/her behavior accordingly. For example, he/she might choose to share information with the firm or change his/her behavior to improve the service process and outcome. Since customers are active goal-seekers, a customer has (if he/she chooses) a great deal of control over service timing. Unfortunately, putting the customer in charge doesn't ensure "good" service timing or a superior service process or outcome (e.g., Chan et al. 2010). It is enlightening to consider a few examples of how people's preferences and behavior depend on service timing.

- *Impulse versus Habit*. People may act impulsively based on their desires but, at other times, they are able to overcome their desire through willpower or self-control (Hoch and Loewenstein 1991). For example, a customer may spontaneously purchase a product that is environmentally unfriendly but h/she may also habitually use recycling services (Lindenberg and Steg 2007; Sheth and Venkatesan 1968). Two major reasons for impulsive behavior are that customers' self-control can be depleted and it can be undermined by conflicting goals and standards, as well as by failing to monitor their own behavior (Baumeister 2002). Hence, the timing of consumer's purchase and consumption of services will sometimes be unpredictable to the firm.
- *Preferences Depend on Circumstances*. Customer preferences seem inconsistent over time because they change as circumstances vary. Indeed, customer preferences can be considered to be constructed (Slovic 1995). For example, the importance weight of a service attribute in determining overall satisfaction with an offering varies over time (Homburg et al. 2006; Lohse et al. 2000; Mittal et al. 2001). Hence, predictive analytics that seek to design and deliver services must take into account the customers' circumstances at a specific point in time.
- *Context can Magnify or Diminish the Importance of Service Attributes*. Customers' beliefs and behaviors are influenced by contextual factors that alter their perceptions of service attributes and perceived risk (Levin et al. 2002; White et al. 2011). Contextual factors can include consumer goals and touchpoints. For example, customers pay more attention to hedonic service attributes when they are browsing than when they are searching; ease of finding products is important

when customers shop in online stores but it is less important when customers shop in a traditional store (Tarasi et al. 2017).

- *Faulty Judgments*. People make estimates (e.g., about waiting or travel time) using an anchoring and adjustment process. However, they make insufficient adjustments and tend be over-confident in their accuracy (Block and Harper 1991; Epley and Gilovich 2006; Yadav 1994). Hence, they are unlikely to make accurate predictions about the timing of their own actions or a service firm's actions.
- *Self-Serving Bias*. Customers exhibit a self-serving bias such that they are more satisfied when they participate in service delivery when all else is equal (Bendapudi and Leone 2003). They are likely to attribute successful outcomes to their own efforts and unsuccessful outcomes to the firm's efforts.

Given these findings, it is not surprising that—when customers have a large number of choices—they are more likely to make unsatisfactory decisions (Scheibehenne et al. 2010). However, service researchers do not entirely understand when customers will make good versus "bad" (i.e., sub-optimal) decisions about services.

A key recommendation for service firms is that they should attempt to align their goals with the customers' goals to achieve service excellence (Bolton 2016). In this way, they can collaborate with customers by providing resources and capabilities that help them achieve their goals. However, this strategy will only be successful—for both firms and customers—when service firms master service timing.

### 2.2.2 The Timing of Small Details Can Make a Big Difference

Based on the preceding discussion, some readers may surmise that effective service timing is difficult to achieve—and its consequences for customers and firms must be difficult to observe. However, effective service timing is a sustainable competitive advantage for some firms. A recent study of successful firms gives many examples and argues that a small detail—i.e., a specific attribute of a service experience such as a sensory input, a discrete emotion, a process element, or an employee action—*that is non-alignable with competitive offerings* has the potential to favorably differentiate service offerings in the marketplace (Bolton et al. 2014). Non-alignable means that "the small detail cannot be directly compared with competitive offerings along a common dimension and has the potential to favorably differentiate the offering" (p. 255). Note that the timing of a service offering is, by its very nature, non-alignable.

An illustrative example is provided by Marriott International, Inc. Its core values include the pursuit of service excellence through "small details" (http://www.marriott.com/culture-and-values/core-values.mi). In the hospitality industry, there are a many discrete service encounters that create the (holistic) customer experience. Each encounter is an opportunity to emotionally engage the customer—often with a

human touch. For example, during evening "turn down service," a maid might fold a towel in the shape of an elephant and place it on the bed—thereby delighting a small child when he or she returns to the room at bedtime. The timing of small details must match customer needs to deliver a superior experience. In this instance, both the parent and child enjoy a special moment during their bedtime ritual.

When timing is "off," the service experience will be unsatisfactory. Most people can easily recall instances when service came as a disruption rather than a benefit. For example, small business customers welcome one-on-one service from a supplier, but not when the representative interrupts their attempt to serve their own customers. Many people enjoy a firm's humorous online video shared by a friend, but dislike any interruption or delay if the video is shown when they are pursuing other goals online.

Traditional approaches to service quality encourage firms to focus on service attributes that are similar across service encounters for both the firm and its competitors. The service firm's goal is to raise average service quality levels and deliver consistent (low variance) service. In contrast, small details that contribute to service excellence must fit with customer needs at a particular moment in time—recognizing what has taken place previously during the customer journey (Bolton et al. 2008). Service timing—designed to fit the customer's context—becomes critical.

Almost all service firms can leverage service timing. In the next section, we will consider four managerial decisions that involve service timing and discuss some of the considerations that might influence how services are designed and executed.

1. *Market segmentation based on time*: how cohort and maturation effects influence the design and execution of services
2. *Designing service encounter sequences over time*: aligning service encounters with customers' current goals
3. *Customer relationship management over time*: how customers different social identities are evoked during different service contexts
4. *Executing service experiences over time*: allowing for customer participation in the design and delivery of service

## 2.3 Market Segmentation Based on Time

When thinking about the timing of service experiences, it is helpful to begin with the long (temporal) view. Who is the customer and what has been his/her journey to this point in time? Managers often avoid any consideration of service timing and fall back on cross-sectional thinking: classifying customers into groups with different needs. Thus, most market segmentation schemes group customers using cross-sectional lifestyle and demographic variables rather than considering customers' needs, preferences and behavior *over time*. However, the distinction between cross-sectional *differences* and longitudinal *responses* is fairly intuitive, as the following example illustrates.

A recent *New York Times* article announced that Generation X, who were born during (roughly) 1962 to 1971, are now experiencing their peak earning years and they "are finding they are not doing as well as they might have expected" (Gebeloff 2017). The article went to distinguish between two different phenomena: maturation (life stage) effects and cohort effects. With respect to life stage, "people 45 to 54 are more likely than others to say they are satisfied with their financial situation" regardless of when they are born. However, the article pointed out that, unlike other cohorts (such as the Baby Boomers), Generation X has consistently expressed dissatisfaction with their economic circumstances regardless of their life stage.

This distinction between cohort and maturation effects over time seems fairly intuitive, but managers have often confused them. Unfortunately, their differences are very important when segmenting and targeting markets to design and deliver interactive services, as well as social and digital media campaigns. For example, many firms are targeting Generation Y (Gen Y) members or Millennials, which are the cohort born (roughly) between 1981 and 1999. A key formative characteristic is their early and frequent exposure to technology; this generation relies heavily on technology for entertainment, to interact with others—and even for emotion regulation. Gen Y members are sometimes called the "Me Generation" because research indicates that narcissism (exaggerated self-perceptions of intelligence, academic reputation or attractiveness) in Gen Y college students is higher than in previous generations of students (Trzesniewski and Donnellan 2010; Twenge et al. 2008).

By definition, a cohort should exhibit systematic differences in values, preferences *and behavior* that are *stable* over time. However, many characteristics commonly ascribed to Gen Y—especially regarding their heavy social media usage when compared to other cohorts—may not be due to their cohort, but rather due to their life stage (Bolton et al. 2013). Most studies of Gen Y examined their social and digital media usage during their high school and college years. There is much less evidence regarding their media usage after they enter the workforce and begin raising a family. Hence, it is dangerous to rely on stereotypes about Gen Y preferences and behaviors regarding services unless the firm distinguishes between cohort and life stage characteristics. Ultimately, the challenge is to distinguish between stable versus time- or context-dependent preferences or behaviors.

The solution to this dilemma is a return to basic principles regarding market segmentation and why it is profitable. Market segmentation is *not* a strategy that involves dividing a broad target market into subsets of consumers who have common need and priorities and then designing and implementing strategies to target them. Instead, it is a process of aggregation—service firms should group together customers who *respond* similarly to actionable variables. Hence, it is important to understand how customers' will respond to service attributes during their specific circumstances at a point in time.

Customers frequently complain that direct marketing activities, such as recommendation systems or personalized advertising, seem poorly targeted. For example, Amazon might recommend a book that you have already read or Facebook serves up an ad for a product or service previously purchased. The primary reason is that the marketers are frequently targeting customers based on "what people like you have

purchased" (i.e., cross-sectional information) rather than leveraging information about the individual customer's preferences or past purchases. Customer relationship management is effective, but—too often—it relies on cross-sectional data and targets customers who are currently profitable rather than longitudinal data that could grow the profitability of customers (Reinartz et al. 2004).

This issue is critical for service firms as they design and execute interactive services—including location-based, retail and self-service technology—as well as develop digital and social media campaigns. What are stable cohort characteristics versus life stage (maturation) characteristics versus time- or context-dependent preferences and behaviors of consumers? The answer to this question requires research that investigates customer preferences and behaviors regarding services. There are no short cuts; service firms need to understand customers' goals, their expectations regarding service, their attitudes toward privacy, their trust (or lack of trust) of service brands, their social and digital media usage patterns and their offline behavior over time. For example, since Gen Y members are highly sought by many service firms, it is useful to consider the following questions:

1. Do Gen Y customers who recommend (or denigrate) a service brand in social media subsequently buy (or boycott) the brand? The answer to this question requires tracking customer behavior across touchpoints—rather than a fragmented view based on a single touchpoint.
2. What are the real-time and long-term influences of word of mouth generated in social media by Gen Y members on *other* members' purchase behaviors, both online and offline? The answer to this question requires a deeper understanding of how people interact with each other over time (i.e., organic word of mouth) rather than how they respond to earned media.
3. How can firms (or public policy makers) use elements of games or play to engage with Gen Y members online, build relationships with them over time and ultimately influence their behavior? The answer to this question requires managers to consider customers many different goals within and across service encounters: contributing, sharing, consuming, searching, participating, or playing (Schlosser 2005; Shao 2009).
4. What service attributes will Gen Y members value as they move through different life stages? Service firms know a great deal about Gen Y's media habits, but much less about its values and enduring behaviors. The answers to this question are likely to be context-specific and depend on service firm's offering, its touchpoints and its markets.

## 2.4 Designing Service Encounter Sequences Over Time

Service firms seek to design and execute service that matches their brand promise—which implies a consistent customer experience across service encounters that take place at different touchpoints. This goal is challenging because firms usually don't have comprehensive view of the customer journey—across multiple service

encounters—because it unfolds online and offline, through interactions with multiple actors, replete with positive and negative emotional and sensory stimulation.

Given these limitations, service managers and academics have often chosen to simplify the service encounter sequence. For example, retailers traditionally viewed shopper behavior in terms of a "purchase funnel" whereby customers (sequentially) browse, search, buy, re-purchase and (perhaps) make a recommendation—despite a reality that is far more complex (Shankar 2011). Hotels often considered a service encounter sequence such as: check-in at a desk, visit room, patronize restaurant, request wake-up call, and so forth—although some innovative hotels have eliminated all these services! However, if we assume the customer is in charge, there are many possible service encounter sequences. For example, retailers now worry about showrooming and webrooming, as well as the use of mobile devices within the store (Mehra et al. 2017).

Consequently, service managers and researchers are challenged to create a (holistic) superior customer experience that encompasses these encounters. Consider some of the issues facing a global service provider.

1. What is important to a particular customer and how does it change across channels, service activities and market contexts? For example, what service attributes are salient to the customer in an encounter that takes place on the customer's premises versus on the firm's premises versus on a website versus via a mobile app versus through a catalog?
2. How should firms design and deliver service when a customer has different emotions, expectations, resources, capabilities and prior experiences at different points on the customer journey—and there is also heterogeneity across customers? For example, customers will have different understandings of their role in co-creating service (e.g., outsourcing the entire task versus a portion of it), as well as different capabilities to participate. How do these differences magnify or diminish the importance of different service attributes?
3. How should firms manage the service experience when a consumer's journey involves different goals (e.g., browse, search and buy) that take place within and across multiple touchpoints over time? For example: Is ease of use or pricing a critical service performance dimension for a specific business customer's goal (e.g., a need for a particular solution) that is pursued via a specific channel or through a particular service activity? Under what conditions?
4. How should global firms manage the customer experience across different contexts, cultures and countries? For example, what service attributes are relevant to customers in countries with different levels of trust and uncertainty avoidance?

Service researchers have recently begun to study how customers weigh service attributes depending on their goals, touchpoints and market contexts (e.g., Tarasi et al. 2017). However, more work is necessary to understand systematic regularities in consumer behavior under different conditions.

Some service firms are addressing these challenges by designing service "modules" that help customers achieve different goals. These modules are easily personalized, customized and integrated with customers shopping practices, so they are

experienced as seamless service encounter sequences. In this way, the service firm and customer collaborate in creating valuable experiences and journeys. For example, American Express is a financial services company that has a unique view of both customer and merchant behavior. It has partnered with other service suppliers (e.g., Facebook) to create different services, such as Members Project, Members Know, OPEN Forum, Link/Like/Love and Small Business Saturday. These modules are aligned with specific consumer and merchant goals; they customize the customer journey and deepen relationships.

## 2.5 Customer Relationship Management at Different Points in Time

Many service firms seek to understand when, why and under what conditions customers will respond favorably and strongly to a firm's relationship-building efforts. Ideally, firms desire customers to embrace customer-company relationships—and become promoters of its services. Service timing creates challenges in creating and managing customer relationships. One reason is that firms often seem to be serving "chameleon customers" who have different needs and preferences at different times and in different contexts. For example, a purchaser of medical supplies for a large hospital might have multiple social identities that are evoked by different situations; he/she may be a doctoral, a business professional, a coworker, a commercial friend and a parent. Each identity evokes different needs, preferences and responses to a service firm's actions (Bolton and Reed 2004).

Firms benefit from supporting customers' social identities—but, to support them, they must know what identities are relevant (or salient) at different points in time—and then design and execute services that affirm and support these identities. Services that are designed and executed in ways that allow multiple identity goals to be pursued synergistically and simultaneously are likely to be highly valued by customers (Fang et al. 2017). For example, Starbucks offers a "third place" where people can enact their workplace identities, as well as enact identities that value environmental sustainability and community, during a single service encounter (See: https://www.starbucks.com/responsibility).

Service firms are interested in identifying or anticipating customer needs and then offering customized solutions. Information from customers' social networks can provide a deeper understanding of customers' attachments and social identities, so that firms can better serve them. For example, Sephora hosts a "Beauty Insider" community for consumers and Teradata hosts a user community for technology users; both communities create value for customers (and for the firm) by sharing information and service/solutions through discussion, blogs, activities, tutorials, and special events. It is noteworthy that these communities excel at leveraging two-way communication and active participation by customers to better serve them in a timely fashion.

Business analytics that leverage social interactions are especially useful in understanding how customers' social identities influence their preferences and behaviors. Research on brand community and customer engagement has shown that customers can become deeply attached to firms and their brands (Brodie et al. 2013; Muniz and O'Guinn 2001), and that these attachments influence their subsequent purchase behavior (Mende and Bolton 2011; Mende et al. 2013). Customers' identification with firms or groups favorably influences their behavior, where organizational identification is defined as a person's perception of oneness with or belongingness to an organization (Mael and Ashforth 1992). Organizational identity has been shown to lead to an increase loyalty behaviors and donations in non-profit settings (Bhattacharya and Sen 2003). In for-profit settings, empirical work has shown that organizational identification increases product utilization, likelihood to recommend the company to friends (Ahearne et al. 2005) and increased willingness to pay (Homburg et al. 2009).

Diagnostic and predictive analytics are useful for innovating and improving services to create, maintain and enhance customer-firm relationships (Verhoef et al. 2003). For example, in B2B contexts, smart machines can report their need for maintenance and repair. Applications are emerging in B2C contexts as well. For example, Apple's Siri can suggest an alternate travel route when traffic is heavy. More research is needed to improve firm's ability to design and execute service that is timely is supporting customer's social needs. Pressing questions include:

1. How can firms develop more timely applications for behavioral targeting to identify customer needs and goals as they emerge within a relationship?
2. What are some ways to coordinate service activities at a single point in time to enable customers to pursue multiple identity goals to simultaneously?
3. How can firms help a customer envision how timely use of a new service delivers relevant benefits and fits into his/her daily life?
4. How should firms insert product/service offerings into the customer's environment (e.g., offers that leverage interactivity in gaming environments) at the right time?

## 2.6 Integrating Customer Participation into Service Over Time

Customer participation is an integral part of the service delivery process—but it is highly variable and difficult to anticipate. Hence, a key challenge for service firms is to design and execute service so that it takes into account customer participation at different points in time. Due to advances in information technology, service firms have plethora of ways to gather and analyze individual customer data over time—so that they can better understand and predict customer needs and behavior. Data sources include: eye tracking, face-tracking, behavioral profiling data, RFID tags, smart devices, wearables, clickstream data, key word search data, "social listening"

data, geo-spatial data, mobile data, portable social graphs, and retail data (Lamberton and Stephen 2016).

However, service firms face many challenges in delivering on the promise of service personalization and customization in dynamic contexts. In particular, in a data-rich environment, the challenge for managers is how to analyze and use customer information in a timely fashion. Wedel and Kannan (2016, p. 105) classify analytical methods into four categories of increasing complexity: descriptive statistics and metrics, diagnostic statistical models, predictive models (including machine learning and cognitive systems) and prescriptive models (that offer "optimal" solutions). They note that, to cope with the volume and variety of data in an efficient fashion, dimensions of the data are necessarily reduced through aggregation, sampling or selection, and simplification of contextual features.

Customers enter a service encounter with certain resources and capabilities. Both customers and service providers must dynamically adjust their behavior as the service experience evolves (Park et al. 1989). This situation is easily recognized in traditional service settings, such as professional services, where employees deliver service. A successful doctor or accountant or hair stylist or waiter learns to assess a customer's knowledge and relevant skills, and then tailor his/her interactions to match the client's needs. For example, a hair stylist might ask a customer to pick a picture out of a magazine that shows the desired cut.

Unfortunately, despite improvements in personalization and customization—especially the provision of pertinent information—the ability to use technology to deliver relevant service to consumers is still a promise—not a reality. One reason is that data reduction and simplification of contextual features increases efficiency—which makes information actionable in real time—but it comes at a cost. Models are likely to be timely, but much less accurate. The primary reason is that accurate predictive models for individual customers (or even groups of customers) will require context-specific data—which is (by definition) highly granular.

Most customers quickly discover that "live chat" on a website isn't suited for complex service requests and that personal assistants (such as Siri or Alexa) are quickly confounded by unusual requests (that can't be found in its database). However, the challenge for service providers goes far deeper than simply improving technology to better respond to requests.

As service experiences unfold over time, customers provide inputs—such as giving information or performing certain required roles—and these inputs influence the quality of service and the customer's progress towards his/her goals (Bolton and Saxena-Iyer 2009). For example, when searching online for a solution, a customer may provide certain information about his/her requirements. A consumer searching on Amazon might request information about a "red sweater" or a business customer might describe the characteristics of a system error. With feedback from the search engine, the customer might then refine his request until a suitable item of clothing (or a software patch) is found. This process iterates, with the customer assessing progress towards his/her goals and modifying his behavior accordingly. The service provider does the same (see Fig. 2.1).

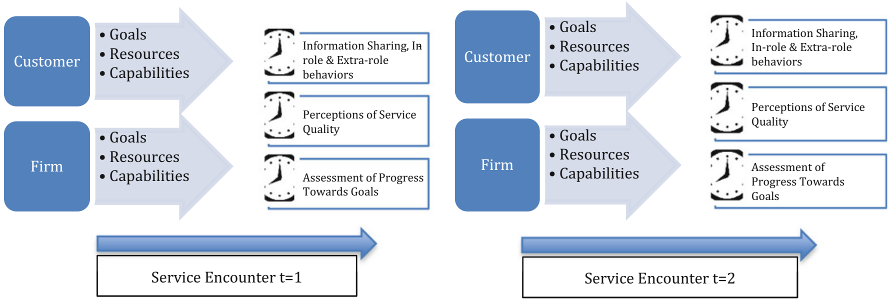


**Fig. 2.1** Co-creation in a sequence of service encounters over time

As this scenario demonstrates, if the customer doesn't carry out his/her role effectively or provides inputs that aren't diagnostic, the service is likely to be low quality. The same observation applies to the service provider's role performance and inputs. The service provider must anticipate many possible paths by which the service experience might unfold (Lemon et al. 2002). These issues are magnified a 1000-fold for more complex services that might involve both customer interactions with technology and employees over a lengthy period of time. Complex services, such as health, financial services and complex business solutions, are especially fraught with difficulties.

A variety of issues arise concerning how customer participation (and firm participation) might unfold over time.

1. How do customers' assessment of progress towards goals influence perceived service quality and customer participation during an extended consumption experience? For example, can geo-targeting be utilized to reach the customer at the right time?
2. How do customers' participation behaviors influence their perceptions of service quality and subsequent efforts? For example, are there ways to provide feedback to customers that improves their role performance and perceptions of service quality? Are there ways for customers to provide feedback to firms to improve their performance?
3. How can firms create a seamless service experience that is consistent across a sequence of encounters given the variability in customer behavior? For example, what are effective ways of delivering content relevant to customer needs through mobile service channels despite device and display constraints?
4. How can service firms leverage two-way communications to proactively manage customized experiences for their customers? For example, are active recommendation systems that explicitly obtain inputs from customers more effective than passive recommendation systems that lack context-specific information?

Each question encompasses a mix of short-run and long-run challenges. For example, many service firms are integrating location-based services into their

offerings today. However, in the future, mobile space-time envelopes require significant improvements to better anticipate customer needs, as well as *where and when* service is relevant (Brimicombe and Li 2006).

## 2.7 Service Timing: Dive Deep into Data

The design and execution of excellent service requires better *timing* of customer-firm interactions because—ultimately—better timing makes service offerings relevant. To achieve better timing, service firms must understand:

- *The Past*: What has been the customer journey to date and what (currently) are the customer's goals?
- *The Present*: What is the customer's current context (touchpoint, servicescape etc.) and his/her resources and capabilities for co-creating service, as well as expectations and risk perceptions
- *The Future*: What are the customer's short-term and long-term goals? How will the customer respond to different scenarios (firm actions and environmental cues)? What might cause him/her to change current behaviors?

Service firms are poised to take advantage of new technologies and data sources to create services that are better timed to meet customer needs. What might improve service timing?

- *Services Triggered by Contextual Cues*: Rather than focusing on (static) customer characteristics, services should be designed and executed based on how customers are responding—and will respond to—to their environment.
- *Service Sequences Customized to Match Customer Goals*. Design customer service experiences that allow customers to pursue their goals using the touchpoints and processes that they prefer: traditional services, (online) interactive services, and intermediary services—and find ways to collaborate to improve their outcomes.
- *Services Designed to Support Customers' Multiple Social Identities*: Services firms should better understand customers' social identities, including their unconscious processes, emotions, habits, and impulses, by integrating data from multiple sources (observational, textual, and unstructured data).
- *Services that Collaborate with Customers during Design and Execution:* Customers will range along a continuum from those who prefer little participation to those who seek to spontaneously co-create. Service firms must be prepared to work with customers who have diverse goals, resources and capabilities.

A common theme among these innovations and improvements to services is the need for iterative learning and adaptation as an individual customer's service experience unfolds.

In today's world, people have welcomed doctors who use robots to guide surgery and cars that can drive themselves. However, these two examples tackle problems

that are well-defined from both customers and suppliers viewpoints. In contrast, anticipating customer needs and collaborating to fulfill them is a more complex feat. In addition, there are many opportunities to innovate and improve services, such as health, education, and financial planning, which are important to society, as well as individual customer's well-being.

### *2.7.1 Methodological Issues: Deep Data and Business Analytics*

Earlier, this chapter argued that service managers and researchers need "deep data"—a fusion of relevant longitudinal data from many sources—to understand and improve customer experiences (Kramer et al. 2004). Service firms need to move towards more complex diagnostic statistical models and predictive models, including machine learning and cognitive systems (Wedel and Kannan 2016). What are characteristics of deep data are appropriate for building more advanced models? Deep data should encompass:

- Observations over time, as well as across customers
- Unstructured, as well as structured data collection (including experiments)
- Measures of sensory, emotional, social, cognitive, behavioral and spiritual experiential attributes
- Information that transcends touchpoints, silos and market boundaries
- Process measures from the quality production process, the quality experience process, and the quality evaluation process
- Multiple actors in networks, where there are simultaneous actions and interactions among by firms, customers and other partners

Excellence in service design and execution requires more than timing—it requires relevance. Service managers and researchers would do well to think carefully about how they exploit data and technology to better serve customers. As Dr. E. O. Wilson (1999, p. 294), the Nobel prize-winning biologist wrote:

> We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely.

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# Chapter 3
# Designing Service Systems to Enhance Perceived Decision Control

**Sriram Dasu and Alexandra Brunner-Sperdin**

**Abstract** The primary purpose of many service encounters is to make decisions. This is particularly true in professional services such as financial services, healthcare, and real estate. In each encounter, many decisions have to be made. Some are trivial while others are highly consequential. The role of the customer in these decisions has a bearing on the outcome, customer's overall assessment of the service encounter, and the cost and complexity of delivering the service. Thus to design service encounters it is important to understand when customers seek decision control and how this control is influenced by the actions of the service provider. In this article, we explore behavioral science literature to identify factors that influence customer's desired role in decision making. It is well known, that trust influences the desire for decision control. This article identifies different dimensions of trust and how trust is influenced by the actions of the service provider.

**Keywords** Decision control · Service interactions · Trust · Service design

## 3.1 Introduction

In professional services such as healthcare, financial services, and real estate, customers seek the help of service providers to make decisions. For example, a couple buying their first home is likely to depend on their real estate agent to assess the relative merits of different neighborhoods, financial advisors help clients approaching retirement develop investment strategies, and pediatricians help parents

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_3

choose treatment plans for their children. In most service encounters, many decisions have to be made. Here we are concerned with the allocation of decision rights between the customer and the provider. Allocation of decision rights has consequences for the service provider and the customer. For the service provider offering choice can be financially expensive. For the customer, in addition to financial costs, there can be psychological consequences. In this article, we explore the psychological dimensions of decision control.

There is substantial research that shows when we choose we are more likely to appreciate an outcome even if it does not match our preferences. In contrast when we do not choose we are less generous in our assessment of the outcomes even when they match our preferences (Averill 1973; Gilovich et al. 1995; Mellers 2000; Lefcourt 1973). A naïve inference might be that customers prefer more choice to less and the service provider should maximize decision rights allocated to a customer while accounting for any economic constraints. The problem clearly is more complex. Customer's desire to make decisions depends on the characteristics of the decision. Further, a customer's willingness to delegate a decision in any situation is influenced by the level of trust in the provider. Thus to optimally allocate decision rights we need to understand factors that influence a customer's desire to make decisions and how trust is developed. Accordingly, in this article we explore the following questions.

1. What decisions would customers like to delegate?
2. What are the dimensions of trust that influence a customer's willingness to delegate?
3. How is trust formed?

## 3.2 Preference for Decision Control

It is well known that behavioral and cognitive control shape our perceptions of service experiences (Surprenant and Solomon 1987; Leotti et al. 2010). An important aspect of control is decision control. Although in general, we seek control yet there are many situations in which we do not want to make decisions. Clearly, patients will not want to make decisions that require deep technical skills. For instance, patients do not want to determine the specific steps a surgical oncologist should employ during a surgery. Even if expertise is not an issue, customers may delegate decisions to the service provider. Examples include tasting menus at restaurants, storylines of television series, and package tours. In addition, there are many trivial decisions that we prefer not to make. Former President Obama is quoted in a Vanity Fair article (Lewis 2012) as saying "I don't want to make decisions about what I'm eating or wearing. Because I have too many other decisions to make." Even when customers want to choose, too much choice can detract from a service experience (Schwartz 2004). Hence, good service design requires judicious allocation of decision control. Decision allocations should be such that the customers feel a sense of control without feeling overwhelmed or creating excessive costs for the service provider.

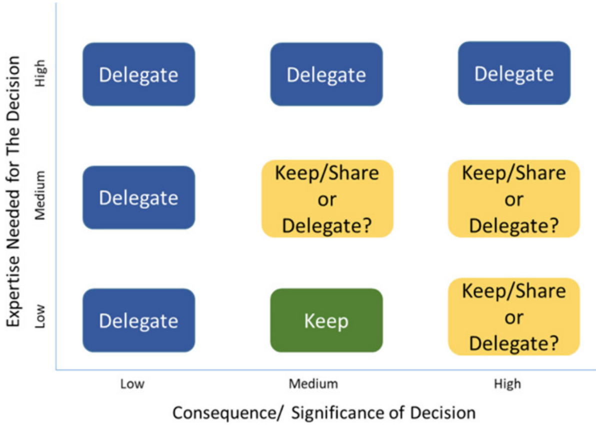


**Fig. 3.1** Customer preference for decision-making

Dasu and Chase (2013) propose two dimensions that drive customers' preference for decision-making. These are (1) the significance of the decision and (2) the depth of knowledge needed to make the decision. A figure based on these two dimensions is below.

Dasu and Chase (2013) conjecture that a customer's preference for delegation increases if the consequences become more significant or the expertise needed to make a decision increases. On the one hand, when we choose or make the decision we are more positively disposed to the choice and any outcomes stemming from that choice. On the other hand, if outcomes are negative and highly consequential, then the psychological burden of choosing and coping with negative outcomes can be overwhelming (Botti and Iyengar 2004). Decision-making creates a cognitive load, internal conflicts, and can cause regret. When consequences are trivial we may prefer to delegate decisions and avoid the burden of choosing. As consequences and expertise needed change there are complex trade-offs among desire for control, a potential for regret, decision conflict, cognitive load and ability to cope with poor outcomes. These trade-offs provide a basis for Fig. 3.1. Interestingly, healthcare is an industry in which decisions span all the cells in Fig. 3.1. There is a vast body of literature on patient decision-making (Edwards and Elwyn 2009; Degner et al. 1997; Botti et al. 2009; Zeliadt et al. 2006). Findings in this literature are largely consistent with Fig. 3.1.

In addition to expertise and consequences, we conjecture that there are at least three other situational factors that influence a customer's desire to make or delegate decisions. The first is the size of the choice set and the second is the desire for surprise in consumption experiences. The third factor is trust. Trust moderates our willingness to delegate.

The literature on choice and decision-making (Hastie and Dawes 2010) suggests that the psychological burden of choice also depends on the choice set. Even when deep expertise is not needed, customers may find decisions difficult and elect to defer decision-making. This occurs when there are many alternatives and there are no clear criteria for making a choice (Beattie et al. 1994; Chernev 2003; Dhar 1997; Iyengar and Lepper 2000). Decision-making frequently creates internal conflict and regret.

As the size of the choice set increases, these unpleasant feeling are likely to grow. The nature and strength of the feelings will depend on whether (a) choices are in the negative domain or in the positive domain and (b) the significance of the consequences. Decision difficulty also depends on the alignment between the attributes of the alternatives (Shafir et al. 1993; Cho et al. 2013). Choosing between two televisions is easier than choosing between a television and a microwave oven. In short, we can expect the size of the choice set and the alignment of the alternatives to have a bearing on the dissonance associated with decision-making. What we know is that in these types of situations the customer may prefer not to choose (Dhar 1997). What is not known is whether they would be comfortable delegating these decisions.

Services have utilitarian and hedonic components (Chitturi et al. 2008). In hedonic services such as sports, movies, and dramas, the primary attraction is our inability to control the flow of events. We call these vicarious experiences. In vicarious experiences, customers value emotional reactions, even when they are very negative (Dunbar et al. 2016). Here customers want to cede decision control.

Thus far, we have focused on the characteristics of the decision—consequences of the decision, hedonic or utilitarian, and level of expertise needed—and the nature of the choice set as a determinant of customer's desire for decision control. Two other factors that matter are individual characteristics of the customer and the level of trust between the customer and the service provider. Clearly, it is important to consider individual differences in need for decision control (Degner et al. 1997). We believe that there is great opportunity for service system designers to develop methods for identifying customer decision control needs and personalizing the service interaction. However, in this article, we do not focus on individual differences.

Trust influences a customer's willingness to cede decision control. Therefore, a deeper understanding of different dimensions of trust, how trust is formed, and how trust influences a customer's disposition towards a service provider is used for service design. Fortunately, we can draw upon a huge body of research on trust (Gambetta 1988; Rousseau et al. 1998). The relationship between trust and decision control has been studied in the context of interpersonal relationships and in organizational dynamics. Both these literatures find that the need for decision control declines with increased in trust. In the next section, we discuss different dimensions of trust.

## 3.3 Dimensions of Trust and Decision Delegation

There appears to be broad consensus that trust in a service provider is equivalent to the expectations held by the customer that the provider will perform a set of actions and can be relied on to deliver on promises even though the customer cannot control or monitor the actions of the provider (Rousseau et al. 1998; Mayer et al. 1995; Sirdeshmukh et al. 2002). There is also wide agreement that trust is a multidimensional construct and three key factors that lead to trust are perceived benevolence, competence, and integrity (Mayer et al. 1995). Trust, however, is a complex phenomenon and the specific elements that matter depend on the context, nature, and duration of the relationship (Rousseau et al. 1998; Rotter 1980; Kramer

1999; Roter and Hall 2006). Trust is known to have an affective and a cognitive dimension.

The need for competence trust arises due to differences in expertise, and these differences make it difficult for the customer to evaluate objectively the provider's competence. Benevolence trust is needed when the interests of the provider and customer are not aligned and contractual enforcement is costly. Competence trust is directly related to depth of expertise. According to Fig. 3.1, as the depth of expertise increases the customers prefer to delegate decisions.

We have seen in the previous section that customers also struggle when they have to choose among alternatives that require comparing two different things, such as apples to oranges (Cho et al. 2013). Shafir et al. (1993) find that in these types of situations customers use simple rules. They rank order the attributes and compare only the top few attributes (Zeliadt et al. 2006). This suggests that when customers have to choose between apples and oranges they will delegate only if they believe the service provider understands their preferences.

We conducted a focus group study with ten wealth managers. Each of them stated that customers would not let them manage their portfolio unless the customer believed that they truly understood the customer's preferences. All the managers strongly believed that understanding preferences was essential for acquiring and retaining customers.

We propose preference understanding as another dimension of trust and call it preference trust. This dimension is different from competence trust. We conducted another preliminary study to explore the difference between competence and preference trusts. We conducted a between-subjects study with four conditions. In each of the conditions, subjects were asked if they would allow a hotel concierge to make a decision for them. We also asked the subjects if the concierge was knowledgeable—a measure of competence. In the first condition the choice set consisted of two beaches; in the second set was three beaches; the third set consisted of a beach and museum; and the final set consisted of a beach, museum, and hike. There was no statistical difference in the perceived competence of the concierge across the four conditions. However, subjects were significantly more likely to delegate decision making in the first two conditions. In the first two conditions, preference was not a major issue while in the third and fourth conditions preference mattered.

Prior research tells us that service designers can influence customer's inclination to delegate decision by enhancing competence, benevolence, and preference trusts. In the next section, we discuss how trust is shaped by a service encounter.

## 3.4 Building Trust

Much of the prior work in behavioral sciences has viewed trust as a static concept (Rousseau et al. 1998; Lewicki et al. 2006). Service operations designers, however, have to worry about how trust develops or is modified by customer interactions. In many services the entire experience may consist of only one or two encounters. Thus there is a need to understand how trust develops during a single interaction.

There are two different traditions in trust research—behavioral and psychological. The behavioral tradition is based on observed choice, while the psychological tradition focuses on perceived expectations. Under the behavioral tradition, trust develops as a consequence of outcomes (Axelrod 1984). The influence of the delivery process or the service interaction itself on trust building is not considered.

Under the psychological tradition, trust is based on expectations of how the trusted party will act. According to that, the interaction is very important. Lewicki and Bunker (1996) propose that during the first few interactions trust is developed through calculations, where the trustor evaluates a trustee and determines the costs and benefits of an engagement. They call this calculation based trust. As the number of interactions increases, each party has greater knowledge about the other party's behavior and this knowledge forms the basis for changes in the level of trust. Lewicki and Bunker (1996) refer to this as knowledge-based trust. Finally, the two entities develop a relationship that creates a joint identity. Lewicki and Bunker (1996) term this type of trust identity-based trust. Although this stream of work lays out a broad framework, it is not concerned with the behaviors and actions in an encounter that influence judgments of trust. For this, we turn to research work that is concerned with personal perceptions.

### *3.4.1 Agency and Communion Traits in Person Perception*

In recent years, many research traditions in social sciences have converged to the view that there are two fundamental dimensions to how we judge others (Bakan 1966; Wiggins 1991; Judd et al. 2005; Fiske et al. 2007; Abele and Wojciszke 2007). Abele and Wojciszke (2007) show that many of the interpersonal evaluation models can be explained in terms of communion and agency. Agency deals primarily with "manifestation of skills, competencies, and status" (Abele et al. 2008), while communion deals primarily with concerns of integrating into a larger social unit through "focus on others and their well-being, cooperation, and emotional expressivity" (Abele and Wojciszke 2007). Agency is also conceptualized as concern about self while communion is about the others and the group. Communal and agency concepts, therefore, correspond closely to benevolence and competence. Given our interest in identifying behaviors of the provider that shape the perceptions of the customer, we use communal and agency traits.

#### 3.4.1.1 Judgments of Benevolence

In the trust literature, Mayer et al. (1995) define benevolence as "the extent to which a trustee is believed to want to do well by the trustor, aside from an egocentric profit motive." A benevolent trustee is unlikely to act opportunistically and thereby mitigates one of the sources of risk for the customer. Combining the definition of benevolence with the classification of person traits proposed by agency and

communal theories, we infer that a trustee whose behaviors are consistent with communal traits will be perceived to be benevolent.

Trait words that are associated with communion are caring, helpful, loyal, polite, sensitive, sympathetic, and understanding. Trait words that demonstrate lack of communion are conceited, dominant, egotistic, and hardhearted (Abele and Wojciszke 2007). Therefore we conjecture that perceptions of benevolence will increase with behaviors that communicate caring, helpfulness, loyalty, politeness, sensitivity, sympathy, and understanding. Behaviors that convey conceit, egotism, and insensitivity will decrease perceptions of benevolence.

#### 3.4.1.2 Judgments of Competence

Agency refers to an individual striving to differentiate through self-expansion, deliberation, dominance, goal attainment, and competence. Prior work has found a positive relationship between agency traits and competence perception (Judd et al. 2005). Traits words that are associated with agency include able, active, assertive, creative, independent, intelligent, rational and self-reliant (Abele et al. 2008). Trait words that demonstrate lack of agency include: insecure, shy, lazy, and vulnerable. Although communion corresponds closely to benevolence, a similar mapping between agency and competence is not forthcoming for a few reasons. First, only a subset of these traits is relevant for judging competence. Perceptions of competence will depend on perceived creativity, intelligence, and rationality. Insecurity and shyness may suggest a lack of competence. The link between self-reliance and perceived competence is not relevant in the context of service interaction. Second, there are several other factors that are known to influence judgment of competence that are not agency traits. These include qualifications, experience (Mayer and Davis 1999), and role norms (Kramer 1999). Thus we need to eliminate some of the variables associated with agency such as self-reliance and vulnerability and include some others such as experience and professional norms (Meyerson et al. 1996). In summary, perceptions of competence will increase with an increase in experience, adherence to norms, and behaviors that demonstrate creativity, energy, and intelligence. Shyness, insecurity, and lack of confidence will decrease perceptions of competence.

#### 3.4.1.3 Behaviors that Convey Benevolence

A large body of research shows that behaviors in service encounters consist of spoken words and non-verbal cues (Argyle et al. 1970; Bonoma and Felder 1977; Rasmussen 1984). Verbal interactions need the support of nonverbal gestures in order to be unambiguously decodable by receivers (Argyle 1973).

Spoken words not only include objective information but also emotional inflections of the speaker that can convey empathy, caring, sensitivity, and understanding (Goodwin and Frame 1989; Surprenant and Solomon 1987). People frequently rely

on verbal communication cues in order to make judgments about other persons. Even if these cues enhance stereotyping (Thagard and Kunda 1998; Kunda 1999), they seem to be a valuable source on which people rely when making inferences about other people (Anderson et al. 1999) in initial encounters.

Non-verbal cues include a range of behaviors such as hand gestures, body posture, smiles, touch, eye contact and gaze, intonations of the voice, and pitch (Cesario and Higgins 2008; Driskell et al. 1993; Carli et al. 1995; Fennis and Stel 2001; Gabbott and Hogg 2001; Friedman et al. 1980).

Spoken words that convey communal orientation consist of addressing the customer by name (Goodwin and Frame 1989), acknowledging the customer's emotional and physical state (Wu et al. 2006), sharing personal observations and emotional response to a customer (Surprenant and Solomon 1987), providing references, softening voice tone when responding to emotional statements (Carli et al. 1995; Scherer and Oshinsky 1977), pausing and allowing time for emotional processing (Wilson and McNamara 1982).

Gestures, that are some of the most obvious body language signals, consistent with communal disposition include eye contact to convey caring (Carli et al. 1995; Surprenant and Solomon 1987), warm smile and gentle touch (Imada and Hakel 1977; Burgoon et al. 1984), and hand movements used to illustrate actions, objects movements, or to point to people and things (Argyle 1973).

Table 3.1 summarizes the sets of behaviors that shape perceptions of benevolence. The high and low conditions result in higher and lower perceived benevolence.

#### 3.4.1.4 Behaviors that Convey Competence

As we did with benevolence, we need to identify verbal and non-verbal behaviors that induce a sense of competence. We label them as task orientation and Information disclosure (TI) behaviors. High TI behaviors require the provider to be active, energetic, confident, and creative. The bigger challenge is identifying behaviors that convey knowledge, intelligence, and technical skills.

Elsbach and Elofson (2000) have shown that managers who explain their decisions are perceived to be more knowledgeable. Use of understandable explanations is seen as a symbol of intelligence and ability (Pfeffer and Salancik 1978; Dellande et al. 2004). From these findings, we conjecture that clear and detailed explanation will influence perceptions of competence.

Speech modulation also impacts perception of ability. People who speak fluently and with a confident and well-modulated voice tone are often judged to be more knowledgeable and capable, while those who give hesitant talks are not (Ridgeway 1987). Gestures to convey high ability consist of eye contact during explanations as well as fluid gestures and pointing (Driskell et al. 1993). Moreover, calm hand gestures as opposed to nervous actions cause service providers to be judged as more able (Taute et al. 2011).

**Table 3.1** Communal behaviors (CB)

| Classes of behaviors | High condition | Low condition |
|---|---|---|
| Verbal Communication Content—spoken words | • Addresses by name (Goodwin and Frame 1989)<br>• Acknowledges customer's emotional and physical state (Ryan et al. 2005)<br>• Shares personal observations and emotions (Surprenant and Solomon 1987)<br>• Provides references | • No reference to name (Goodwin and Frame 1989)<br>• Oblivious to emotional and physical state (Wu et al. 2006)<br>• Stays on task-related information (Surprenant and Solomon 1987)<br>• Does not volunteer references |
| Speech Modulation | • Softens voice tone (Carli et al. 1995; Scherer and Oshinsky 1977)<br>• Pauses and allows time for emotional processing (Wilson and McNamara 1982) | • Flat voice unreactive (Scherer and Oshinsky 1977)<br>• No pauses (Wilson and McNamara 1982) |
| Gestures, Eye Contact, and Posture | • Eye contact (Surprenant and Solomon 1987; Carli et al. 1995)<br>• Warm smile (Burgoon et al. 1984)<br>• Direct body orientation (Imada and Hakel 1977; Burgoon et al. 1984)<br>• Hand movements used to illustrate actions (Argyle 1973) | • Minimal eye contact (Surprenant and Solomon 1987)<br>• Minimal affective response (Burgoon et al. 1984)<br>• No contact (Burgoon et al. 1984)<br>• No hand movements |

Table 3.2 summarizes the sets of behaviors that we conjecture shape perceptions of competence. The high and low conditions should result in higher and lower perceived competence, respectively.

Brunner-Sperdin and Dasu (2015) conducted a set of experiments to test whether the behaviors in Tables 3.1 and 3.2 shape perceptions of benevolence and competence. They developed a set of vignettes based in healthcare. Their study finds that task orientation and information disclosure does result in higher competence trust and communal behaviors impact benevolence.

Researchers who study person judgment (Fiske et al. 2007; Rosenberg et al. 1968; Judd et al. 2005) have found that communion and agency judgments are often correlated. Rosenberg et al. (1968) reveal that interpersonal judgments about individuals who are seen as possessing more positive and social qualities are also seen as possessing more positive intellectual qualities and vice versa. The correlation may be due to a halo effect or because of likeability. Judd et al. (2005) also suggest that individuals who are judged to be competent are also perceived to be warm.

Abele and Wojciszke (2007) find that agentic traits of the provider are at times perceived as warm or benevolent. This happens when these traits benefit a customer. Elsbach and Elofson (2000) find that managers who provide explanations are perceived to care for the employees. Finally, Rosenberg et al. (1968) suggest that warmth and competence judgments are frequently positively correlated.

The above discussion suggests that communal behaviors can influence perceptions of competence and agentic traits can influence benevolence. Brunner-Sperdin

**Table 3.2** Task orientation and information disclosure (TI) variables

| Classes of behaviors | High condition | Low condition |
|---|---|---|
| Verbal Communication Content—spoken words | • Common language detailed explanations (Pfeffer and Salancik 1978)<br>• Statements of experience (Mayer and Davis 1999) | • Jargon and abbreviated explanations (Pfeffer and Salancik 1978) |
| Speech Modulation | • Fluent (Ridgeway 1987)<br>• Well-modulated (Ridgeway 1987)<br>• No hesitations (Ridgeway 1987; Carli et al. 1995)<br>• Confident (Ridgeway 1987) | • Disfluent (Ridgeway 1987)<br>• Hesitant (Ridgeway 1987) |
| Gestures, Eye Contact, and Posture | • Calm hand gestures (Taute et al. 2011)<br>• Fluid gestures and pointing (Driskell et al. 1993)<br>• Eye contact during explanations (Driskell et al. 1993) | • Nervous activity—clicking pen (Taute et al. 2011)<br>• Inconsistent eye contact (Carli et al. 1995) |

and Dasu (2015) also tested for these interactions. Surprisingly, in their experiments, they did not see an impact of communal behaviors on competence trust but task orientation and information disclosure led to higher perceptions of benevolence. It will be interesting to test if their finding generalizes to settings other than healthcare.

#### 3.4.1.5 Judgments of Preference Trust

How do customers determine whether or not the service provider understands their preference? This dimension of trust is concerned with the service provider's familiarity with a customer's situation and tastes. Unlike competence trust, customers have more information and are in a better position to query a provider to determine preference trust. Based on our preliminary study with wealth managers, we find that customers infer this through a series of questions about their own situation and the provider's prior experience with similar customers. The key here appears to be for the provider to develop a deep understanding of the different customer segments.

## 3.5 Conclusions

In many services, the main purpose of the interaction is to make a set of decisions. A customer's role in these decisions influence the customer's experience and has economic consequences for the service provider. Therefore service designers must understand factors that shape a customer's desire for decision making and the psychological costs and benefits a customer incurs as a result of making decisions.

These insights can be used to optimize the allocation of decision rights. Based on findings in behavioral sciences we posit that desire to make decision depends on the consequences of the decision, whether the decisions are in the negative domain or positive domain, the expertise needed to make a decision, the size of the choice set, and whether choice entails comparing apples to apples or apples to oranges.

It is well known that trust moderates a customer's willingness to delegate. Thus by building trust, a service provider gains greater latitude in allocating decision rights. We discussed the key dimensions of trust and provider behaviors that influence perceptions of trust.

The focus of this article was on situational variables. It is well known that individuals differ in their need for cognition (Cacioppo and Petty 1982) and resilience (Wagnild and Young 1993). Thus, we need to research and develop systems that are sensitive to individual differences. A major challenge here involves developing methods for discovering individual preference during service. Potential approaches include (a) offering a set of options and allowing customers to signal their preference, (b) mine prior history, and (c) use a triaging system such as a questionnaire.

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# Chapter 4
# The Sequence of Service: An Affect Perspective to Service Scheduling

**Michael J. Dixon and Liana Victorino**

**Abstract** Research from the behavioral sciences offers many insights into how customers perceive the sequence of service and how these perceptions influence their decision-making and evaluation of the customer experience. This chapter offers a comprehensive literature review of foundational behavioral research that can help inform service scheduling practice. Topics covered include the peak effect and the following sequence effects: peak placement including an early peak versus a delayed peak, trend, spread, end, and duration. An affect perspective is taken to understand how customers respond to these different service scheduling strategies. Two studies that have examined affect-based service scheduling and applied temporal decision theory are also described to illustrate how these behavioral insights can be leveraged when scheduling the customer experience.

**Keywords** Sequence effects · Peak effect · End effect · Peak placement · Touchpoints

## 4.1 Introduction

To strategically distinguish themselves from the competition, more and more service firms are looking for innovative ways to enhance the *customer experience* (Dasu and Chase 2013; Pine and Gilmore 1998; Verhoef et al. 2009; Voss et al. 2008; Zomerdijk and Voss 2010). Research has followed suit, examining how customer experiences can be engaging, memorable, compelling, and largely intangible

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_4

(McLellan 2000). Much of this research has focused on the affective and sensory responses customers have to specific service elements (Kranzbühler et al. 2017). The resulting *affect* that a customer experiences refers to a state of feeling, also known as a "valenced-feeling state" (Cohen and Areni 1991, p. 190). This feeling state might include mood, which would be lower in intensity, or feelings of a particular emotion, which would be higher in intensity (Erevelles 1998). Affect often induces behavior with very little cognitive or conscious consideration (Cohen and Areni 1991) and has been described as a leading cause for consumption behavior (Holbrook and Hirschman 1982).

Affect plays a role in how customers evaluate an experience and can also influence their choices. Customers make these evaluations and choices based on reflections of past experiences and predictions about future experiences. Taking the lens of decision theory, people use *global* and *retrospective evaluations* so individual events and life moments can be summarized in a coherent and meaningful way (Fredrickson 2000). Global evaluations are measurements of an experience after it has come to some conclusion and can be considered a measurement of the customer experience. These summaries are also used in judgment processes and subsequent decision-making situations. Specifically, customers use global evaluations to make predictions of their future affective states resulting in decisions being made that attempt to maximize their predicted future affect.

One affect-based consideration that has a strong influence on the customer experience, but has been understudied thus far, is the sequencing of encounters, touchpoints, episodes, moments or events. Lemon and Verhoef (2016) stated that "the effect of an individual touch point may depend on *when* it occurs in the overall customer journey" (p. 83) and this temporal effect merits further study. Therefore, service researchers must think about how customers will respond to the sequencing of the customer experience. For example, choices such as *when* events happen, in *what order* events happen relative to other events, the *speed* at which events happen, *when decisions* are made, and the c*ontrast* of events to other events in a temporal space are all relevant considerations of service schedules.

To that end, this chapter provides an in-depth review of research related to understanding how the sequence of events in a service schedule influences the affective response of customers. The objective, of course, is to schedule these events in an ideal sequence that enhances the customer experience. Historically, service scheduling efforts focused on optimizing efficiency or throughput. This chapter, takes a different view and introduces the concept of *affect-based service schedules*, that is, the scheduling of a sequence of encounters, touchpoints, episodes, moments or events in such a way that customer affect is maximized. For the remainder of this chapter, the terms "events" and "moments" are used with the intent that these are interchangeable with the terms encounter, touchpoints, episodes, events, and moments. The literature review highlights the influence that service scheduling decisions have on customer affect and positions affect-based service scheduling as an important characteristic for service organizations to consider and plan for.

Research on affect-based service scheduling fits within the broader customer experience literature. The term customer experience has become an umbrella construct (Hirsch and Levin 1999) that is meant to capture aspects of other constructs

such as customer satisfaction, customer loyalty, service quality, customer relationship management, and customer engagement (Lemon and Verhoef 2016). Recently researchers (Kranzbühler et al. 2017; Lemon and Verhoef 2016) have reviewed the customer experience literature and agreed that it is a multi-dimensional construct that involves the cognitive, affective, physical, sensorial, and social responses to a service offering (Schmitt 1999; Verhoef et al. 2009).

Much of the research on customer experience to date has focused on brand experiences (e.g., Brakus et al. 2009) or aspects of a customer's journey that are related to pre-purchase (e.g., Hoyer 1984) and purchase experiences (e.g., Baker et al. 2002; Ofir and Simonson 2007). While other customer experience research focuses on the post-purchase consumption (e.g., Holbrook and Hirschman 1982) or product use (e.g., Vargo and Lusch 2004). Other research streams study how customers interact with a service provider for example the servicescape (Bitner 1992), service scripting (Victorino et al. 2013), interpersonal interactions between customers and employees (Bitner et al. 1994) and customer crowding (Hui and Bateson 1991) among others.

Marketing scholars Holbrook and Hirschman (1982) began using the term customer experience to describe how consumers are not purely rational, that the cognitive elements of an experience can explain only a small degree of their overall evaluations. Instead, they associated a customer's experience with the emotional and affective responses elicited during the experience. Similarly, operations scholars Chase and Dasu (2001, Dasu and Chase 2013) have encouraged researchers and practitioners to consider the emotional responses of customers as a means to enhance the delivery of service operations. These affect-based considerations have been coined the "soft-side" of service operations management (Dasu and Chase 2010) in comparison to the more "hard" issues and measures that often get considered in the operations management field such as efficiency, capacity, and throughput improvements.

To add to the discussion of affect-based considerations of the customer experience, this chapter reviews relevant literature from the behavioral sciences to help inform service scheduling practice. In specific, research on the peak effect is reviewed as well as the following sequence effects: peak placement including an early peak versus a delayed peak, trend, spread, end, and duration. Incorporated within the literature review are concrete examples, primarily from experiential service contexts (e.g., theme parks), to showcase how these concepts can be used when developing service schedules. Finally, to further illustrate how these behavioral insights can be used to enhance the customer experience, two research studies related to affect-based service scheduling are described.

## 4.2 Literature Review

The sequence of service such as the placement of high or low points or the resulting trend can influence the customer experience (e.g., Chase and Dasu 2001; Cook et al. 2002; Dasu and Chase 2013; Verhoef et al. 2004; Zomerdijk and Voss 2010). This section reviews relevant research from the behavioral sciences related to the peak effect and a variety of sequence effects. Although the focus of this chapter is on sequence effects, it is important to first describe the importance of the salient or peak events within an experience largely because affect-based service scheduling involves the sequencing of moments of different valence intensities. Following a review of the peak effect, the remainder of the literature review is dedicated to specific sequencing effects.

### *4.2.1 Peak Effect*

Not all elements of an experience are equally weighted in retrospective or predictive evaluations. From a hedonistic standpoint, most of us make choices that we predict will maximize our pleasure in life and minimize our pain (Loewenstein and Schkade 1999). Our predictions of these future states are heavily influenced by the memories of the past and yet our memories are fragmented. In other words, we don't recall every detail of every second of our lives because the cognitive load of doing so would likely overburden us. For that matter, people are unlikely to integrate, sum, or average the measurements across an experience, rather they focus on the key (i.e. peak) moments to be representative of the entire experience (Ariely and Carmon 2000; Kahneman 2000).

Additionally, people tend to use prototypical moments to make judgments about the past and decisions about the future (Schreiber and Kahneman 2000). Research has noted that our memories are more similar to a series of photographs rather than a film recording (Fredrickson and Kahneman 1993). For example, this premise was found true in research about how people remember vacations (Kemp et al. 2008). When asked, "How was your vacation?" a person could form a representative assessment of the trip by averaging the level of enjoyment during their entire vacation to describe their average hourly enjoyment. If so, the person would likely find that their average enjoyment level might be quite low if the hours spent traveling and sleeping were considered. Instead, people typically form answers by describing the most exciting or novel aspect of their vacation, which is often referred to in the literature as the peak effect. These aspects may be far from typical and in fact may be very anecdotal, but are often used as a heuristic in forming an assessment of our experiences.

Much of the research on the peak effect originates from the work of Nobel laureate, Daniel Kahneman, and his many colleagues. Among his more famous work was the proposal of loss aversion with Amos Tversky (Kahneman and Tversky

1979). Kahneman and Tversky described that people contrast decisions against established reference points, and a negative contrast often feels worse than an equally measured positive contrast. Loss aversion has led to multiple streams of research including a better understanding of risky behavior (Slovic et al. 1986) and decision framing (Tversky and Kahneman 1985, 1986). However, in the context of evaluating experiences, it has led to an assumption that moments in our life are evaluated in comparison to other moments, in particular, to the moments that are most salient (i.e., peak moments).

Similar to contrasting expectations with perceptions, contrasting non-peak and peak moments lead to global evaluations of experiences. Marketers have noted that expectancy disconfirmation often leads to satisfaction and dissatisfaction when service outcomes exceed or disappoint customer expectations (Johnston 1995; Oliver 1980). Decision theorists assume that when people form summary evaluations of a series of moments they use a similar method of disconfirmation to contrast individual moments—particularly as it applies to our affective states, e.g., happiness, sadness, anger, joy, fear, etc. However, the concept of global evaluations based on moments (Kahneman 2000) differs from the idea of evaluation based on expectations (Oliver 1980). Expectations are largely influenced by messaging (i.e., marketing or word of mouth) while the idea of evaluation by moments is to cognitively summarize multiple portions of an experience (i.e., moments). Thus, to compare moments, past experiences are recalled, and then our current experience is considered or predicted future experience on a scale of affective response.

Moreover, Tversky and Griffin (1991) stated that highly salient moments could be used to both increase or decrease our future states of happiness. Our memories of peak moments can endow us with more or less happiness; and, current moments can be contrasted against remembered peak moments. The notion of a contrast effect implies that people use the most salient moments—the high-water marks in our experiences—as a calibration mechanism. As implied in adaptation level theory, our peak moments will change our perception of future moments based on the emotion levels one has grown accustomed to (Helson 1964). The subjectivity of customer evaluations of services is amplified by their past experiences explaining why measuring and comparing services is often so difficult. For example, two customers having experienced the same service can rate it in different ways due to, among other reasons, the presence of peak moments in an individual's past.

In addition, the memory of key moments might not be the entire story. In fact, some early economists recognized that the evaluation of a specific moment has three aspects: predictive utility (i.e., what you expect your affective response will be in the future), experienced utility (i.e., what your affective response is in the moment), and remembered utility (i.e., what you recall your affective response was in the past) (Bentham 1781; see also Kahneman et al. 1997). Others have posited that singular moments in time may be triple counted by first anticipating future events, next experiencing the event, and finally remembering the event (Loewenstein and Elster 1992). This follows the idea that affect can come from information, not just experience (Schwarz and Clore 1983).

The use of the term "utility" in this context is similar to our discussion of affect, i.e., a hedonic valence measurement of pleasure and pain (Kahneman et al. 1997). Erevelles (1998) reported that there are two types of conceptualizations of products or services, utility-related (i.e., product attributes and performance) and hedonic-related (i.e., experiential, esthetic, and emotional aspects). Similarly, Kahneman et al. (1997) reported that there are two types of understandings of utility: one being the outcomes and attributes associated with a decision, and the other the subjective hedonic experiences associated with an experience. As with Kahneman et al. (1997), this chapter uses the term to mean the hedonic elements of an experience more closely associated with the affect an event might induce.

A case has also been made that among the three, remembered utility is the most important because it largely dictates what will be done in the future. For example, Kahneman and colleagues argued that experienced utility matters primarily because it influences our memories (Kahneman et al. 1997). Additionally, Loewenstein and his colleagues made a case for the value that comes from anticipating future good moments (Loewenstein 1987; Loewenstein and Schkade 1999); mainly, that anticipation itself has utility and once experienced, the moment no longer carries anticipatory utility. The idea of anticipation will be explored further in a later section. However, it is safe to say that the memory and anticipation (or dread in negatively valenced moments) of peak events are largely used as heuristics in calibrating experience expectations.

Just as contrasting remembered experiences influences the prediction of future experiences, the habituation or acclimation that occurs from an ever-increasing recalibration of a baseline further erodes or magnifies the affective impact of future experiences. For example, a study of lottery winners found that winners rated mundane pleasures lower than did a matched control group of non-winners (Brickman et al. 1978). One explanation of this result is that the winners had been habituated to a higher level of an affective response having experienced a peak event of winning a lottery. Furthermore, it was found that the peak moment of winning a lottery had led to a re-imagination of the lottery winner's past happiness. Therefore, peak events can act both to contrast against past experiences and habituate expectations for future satisfaction.

Service providers can apply concepts of the peak effect to enhance customer experiences. For example, Sea World San Diego has attempted to create individualized peak moments for its customers by providing what they term as "Exclusive Park Experiences" ("Premier Experiences," n.d.). In these experiences, customers can interact with beluga whales, dolphins, or penguins in a "behind-the-scenes" and "close-as-possible" manner "getting a real insider's perspective on the animal care and training methods" used at Sea World. Also, they have encouraged their zoological staff to invite small groups or families into a behind-the-scene interaction with some of the animals providing an unexpected moment of delight. They are hoping that these interactions will result in higher customer evaluations of the overall park experience and provide a salient and memorable moment for customers.

In summary, peak moments influence the global evaluations a customer might have of an extended customer experience. Highly salient aspects of an experience

can drive anticipation of future experiences, dictate memories of past experiences, and calibrate other non-peak aspects of an experience. Understanding that customer evaluations of an experience are often not a summation of all individual aspects should lead service providers to budget resources in ways that ensure the presence of and amplify the valence of positive peak moments while eliminating or reducing the saliency of negative peak moments.

### *4.2.2 Sequence Effects*

In the following sub-sections, relevant behavioral science research on sequence effects are reviewed. To motivate this discussion, the concept of *experience profiles* (Ariely and Carmon 2003; Bitran et al. 2008), must be introduced. Figure 4.1 shows an example of an experience profile. Experience profiles were developed and used by behavioral researchers to plot affective response measurements over a period of time. Using experience profiling, service providers can map out the customer experience along an expected scale of affective response and begin to consider the effect of scheduling events in different ways. The peak, as previously mentioned, acts as a calibration mechanism for an experience profile scale; therefore, the advantages for scheduling that peak early in an experience and the alternate option of scheduling it for later are both described. Furthermore, Ariely and Carmon (2000) stated that there are two categories of factors that influence evaluations of experiences profiles: static characteristics like the intensity of peak and end moments, and dynamic characteristics like the trend and rate of change of moments (see Fig. 4.1). As such, we will discuss the dynamic characteristics of a sequence by considering the placement of the peak either early or delayed, the trend of an experience, the spreading out of multiple high valence moments, and the duration of an experience.

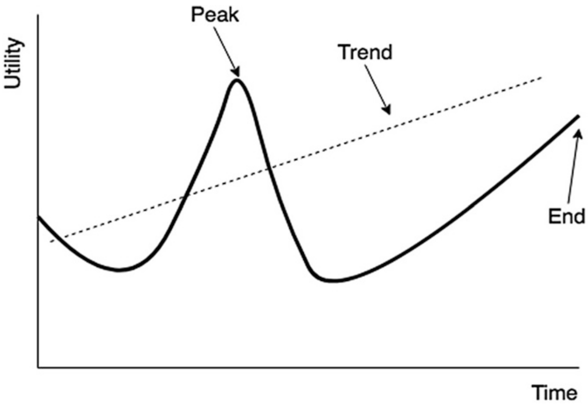


**Fig. 4.1** "Experience profile" example. *Source: Author's personal drawing based on* Bitran et al. (2008)

It is also important to note that, at this juncture, the peak moment is not the only heavily influenced moment in time—the beginning and the end of an experience alone, regardless of its saliency, tend to be heavily weighted; hence, these temporal effects are embedded into the discussion throughout this section including a specific sub-section on the end effect.

## 4.3 Peak Placement: Early Peak

The sequence of moments has received attention from economists for quite some time now (e.g., Koopmans 1960; Samuelson 1937) as they are often interested in understanding the total utility that a consumer might receive from some set of time-elapsing outcomes. Traditionally, the prevailing economic fashion of estimating total utility for such a set would be to apply a constant discount rate to the individual moment's utility and then sum the discounted utilities. Economic theory poses that when considering only one event, delayed moments are valued less than more immediate ones (Frederick et al. 2002) resulting in a discount rate that favors earlier moments. Those relying on the discounted utility approach would claim that $100 today is worth more than $100 in the future. In fact, you would have to give a rate of return equal to some positively discounted rate to make the future payout equivalent to the immediate payout. In other words, traditional economic theorists would recommend that higher valenced moments be placed earlier, suggesting that people would prefer sequences that decline over time.

Early peak preference prescribed by the discounted utility approach to sequencing points towards our impatience (Koopmans 1960) and uncertainty about the future (Knight 1921). People want good things right away because they view that there is no time to lose. Furthermore, people are uncertain that the future will allow them to have such good fortune, so it is better to get it now while we can. The notion of, "eat, drink and be merry for tomorrow we die" explains why people tend to not have a taste for delayed consumption and prefer immediate gratification.

There have been some empirical studies that support the preference for early peaks. For example, Thaler (1981) showed that consumers expected to be rewarded for a delay in receiving monetary or consumer goods. Also, a study by Loewenstein and Prelec (1993) found that 82% of the participants who said they like French food preferred having a fancy French dinner in 1 month's time rather than 2 months. The takeaway is that when asked when people would like something good to happen to us, we often say, "right away."

Multiple studies have also shown that people overestimate their prediction of future affective states largely based on their current state (e.g., Gilbert et al. 1998; Loewenstein and Schkade 1999). For example, a study by Brickman et al. (1978) found that both lottery winners and accident victims rated their predicted future happiness higher than did a matched control group. Their peak moment (i.e., winning the lottery or experiencing a major injury from an accident) changed their view of future states. This future-looking contrast provides further support for an

early peak if it allows customers to see future experiences through rose-colored lenses. Moreover, service researchers have also proposed that moments of delight that occur early in an experience can lower the threshold for subsequent expectations (Johnston 1995).

There is also a rich literature on the serial position effect in which researchers have found various conditions where primacy or early positioning seems to be more or less important than late positioning or recency as it applies to memory, impressions, and persuasion (Feigenbaum and Simon 1962; Murdock Jr 1962). Most notably, arguments for considering primacy in impression formation include: the change-of-meaning hypothesis—early impressions, once formed, are used to benchmark later evidence (Asch 1946) (very similar to anchoring effects (Strack and Mussweiler 1997)); inconsistency discounting (Anderson and Jacobson 1965)—evidence contrary to earlier evidence is discounted; and finally, attention decrement (Crano 1977)—attention to additional information decreases overtime so what happens first is used to form impressions.

Since much of how customers perceive a customer experience depends on impressions, the “first impressions” point of view is important to consider. For example, to create a good first impression, Sea World San Diego has redesigned the entrance to their park to include a thematic tidal wave gate entrance leading immediately to a coral reef tidal exhibit that allows customers to interact with aquatic animals found around reef areas. Before the redesign, the visitors had to walk some distance to find one of the first exhibits or rides. Now, upon entering the park, customers are immediately greeted by enthusiastic employees and an attraction that is designed to be immersive and educational leading to a salient moment early in the day.

When considering negative moments, researchers have found that most people have a preference for more immediate pain rather than delayed. For example, Thaler (1981) found that people were less willing to put off having to pay a fine than to put off a reward. Another experiment found that when a peak pain moment was followed by a less painful ending that was unnecessarily extended, the overall rating of pain decreased (Kahneman et al. 1993). The explanation of this phenomenon is that the peak pain was pushed further from the end (i.e., closer to the beginning) and was thus less salient to the individual. Lower evaluations of overall pain when the peak pain moment occurs further from the end can also be explained by memory decay or the likelihood that people forget moments in the distant past more than more recent moments (Anderson 1995).

In summary, a service provider might consider an earlier positive peak if they suspect their customers are impatient, uncertain about the future, prone to establishing positive future perceptions after a peak moment, discount later inconsistencies, lose interest or attention during later periods, or are highly influenced by first impressions. In addition, negative peak moments are better scheduled further from the ending based on memory decay. Although these reasons seem sound, there are also equally compelling reasons to delay the peak. These reasons are reviewed in the next section.

## 4.4 Peak Placement: Delayed Peak

Since peak moments carry heavy weight in the evaluation or prediction of sequences, the discounted utility understanding of when a peak should occur assumes that the peak is considered in isolation without consideration of other moments around it. This leads to the primary fault that decision theorists have found with the discounted utility approach that when peak moments are considered jointly with other moments our preferences seem to change dramatically, i.e., our preferences are not consistent across time and within choice sets (Frederick et al. 2002). Researchers have also shown that our internal utility optimization heuristics are significantly different if we consider our choices as sets of outcomes that are interrelated rather than just individual moments (Read et al. 1999). In other words, people's preference for the preferred timing of a peak moment changes if the moment is presented in the context of other moments (Loewenstein and Prelec 1993).

Some value has been found in delaying positive peak moments, if only to be able to gain utility from the savoring of a future expected peak. The concepts of savoring and dread assume that affect is not only the outcome of experiencing an actual moment, but can instead be conjured within our minds by simply picturing future moments (Schwarz and Clore 1983). In several studies, researchers have found that participants that vividly imagined future outcomes made different decisions and rated experiences higher (e.g., Chun 2009; Kwortnik and Ross 2007; Shiv and Huber 2000). Other research has shown that people who are more prone to savor positive outcomes are happier and have improved well-being (Jose et al. 2012).

The idea that positive affect can be derived from savoring a future peak event suggests that peak events should be delayed to allow for additional time to savor. For example, people preferred to delay finding out if they have won a lottery to enhance the affect that might come upon winning (Kocher et al. 2014). Research has also found that enjoyment increased when consumption was delayed for pleasurable and vivid products, for example, chocolate or wine (Nowlis et al. 2004). Moreover, social norms such as "saving the best for last" or having "happy endings" seem engrained in social psychology (O'Brien and Ellsworth 2012; Ross and Simonson 1991). Researchers have also suggested that it is preferable to experience bad moments before good moments (Kahneman and Miller 1986). For example, in a study, where participants were asked their preference of sequence for visiting a friend and an abrasive aunt, 90% chose to visit the aunt first (Loewenstein and Prelec 1993).

A strong ending can be a compelling service scheduling strategy (Chase and Dasu 2001). For example, during the winter season, Disneyland Park brings the holiday spirit to life for park guests. One way they achieve this is by ending the day with the "grandest of grand finales" themed around the holidays ("Believe in Holiday Magic," n.d.). The finale begins with a spectacular firework show over Sleeping Beauty's Castle which is glimmering in lights and frosted with icicles. Then to add to the holiday magic, it starts to snow on Main Street, U.S.A. turning the California night into a winter wonderland. This grand finale leaves guests with a positive and lasting impression of their day at the park.

In summary, service providers may consider scheduling the peak later in contexts where customers are more capable of observing heterogeneity between moments and can enrich the customer experience through savoring an anticipated peak moment or recovering from a lower valence moment by ending on a high note. Additionally, a peak moment placed later in an experience profile leads to sequences that improve, rather than decline, over time. This effect is described in the following section.

### *4.4.1 Trend Effect*

An improving trend has been shown to be preferred in a number of studies across different contexts such as grade sequence (Moya 2006), change in salary over a lifetime (Hsee et al. 1991; Loewenstein and Sicherman 1991), streams of discomfort (Ariely 1998; Varey and Kahneman 1992), headache pain over time (Chapman 2000), and, sequence of performing arts events in season subscriptions (Dixon and Verma 2013). A sequence of events that improves over time, is known as a trend effect.

An important theory that helps to explain the preference for improving sequences is the concept of loss aversion which was introduced within the chapter already when explaining the peak effect. To elaborate, reference points get updated by the most recent moment; hence a declining sequence would feel like a series of losses from a series of reference points, and the opposite would be true for an improving sequence. A loss feels worse than an equal amount of gain feels good (Kahneman and Tversky 1979); therefore, loss aversion helps to explain why there is a preference for upward trends; similarly, loss aversion also explains why people prefer a delayed peak.

Primarily led by behavioral decision theorist, Christopher Hsee, a set of studies also considered the rate of change in experience profiles (Hsee and Abelson 1991; Hsee et al. 1991, 1994). For positive (i.e., inclining) sequences, they showed that participants were happier with a faster rate of change. Alternatively, for negative changes, people are less unhappy with slower rates of change. Also, the velocity of the trend has been shown to be important in reactions to advertisements (Baumgartner et al. 1997), salary advancements (Clark 1999), a series of gambling outcomes, and stock earnings (Hsee and Abelson 1991). Researchers in service operations have also found support for sequences finishing with a "steep rise" (Dixon and Thompson 2016; Das Gupta et al. 2016).

As an example, Disneyworld's Magic Kingdom, through its scheduling of parades and interactive mini-shows, builds an upward trend of momentum. Park guests can start the day with a 5-min opening ceremony ("Let the Magic Begin," n.d.). Visitors can see a mid-day 35-min street party parade ("Move It! Shake It! Dance, and Play It! Street Party," n.d.) and a 12-min afternoon fantasy parade ("Disney Festival of Fantasy Parade," n.d.). Throughout the day there are many other small "atmospheric" events that repeat themselves. But, as the day comes to a close the park lights up for its finale. Then there is another parade followed shortly by a light show ("Once Upon A Time," n.d.), a firework show ("Wishes nighttime spectacular," n.d.), and an electric water pageant on the lake ("Electrical Water Pageant - Magic Kingdom Park," n.d.).

In summary, an experience that results in an upward positive trend in affect has been shown to influence customer experiences in multiple contexts. Service providers can strategically consider the valence level across an entire experience and attempt to create an upward affective trend if they consider their customers are prone to loss aversion. While the trend effect suggests starting with low valence moments that progressively lead to an ending with high valence moments, other research suggests that positively valenced moments are important at both the beginning and the end. This research is discussed in the next section.

### 4.4.2 Spread Effect

The arguments thus far about the placement of peak moments have focused on early and late peaks—both the beginning and the end. These positions seem at odds with one another; however, there are researchers that recognize the importance of both. Early service researchers, for example, identified the importance of "service bookends" that is, both the beginning and the ending of the customer experience (Heskett et al. 1990). In other words, scheduling the customer experience so that the peak events are spread out from one another. Research has examined the influence of the spread effect. For example, a study on performing arts season subscriptions found that subscriptions were more readily repurchased if the overall trend was positive, if the last event had higher utility, and if the highest utility event (i.e., peak) occurred earlier in the subscription (Dixon and Verma 2013). The result was a sequence with a high utility event near the beginning and near the end resulting in a preference for spreading out positive outcomes as illustrated in Fig. 4.2.

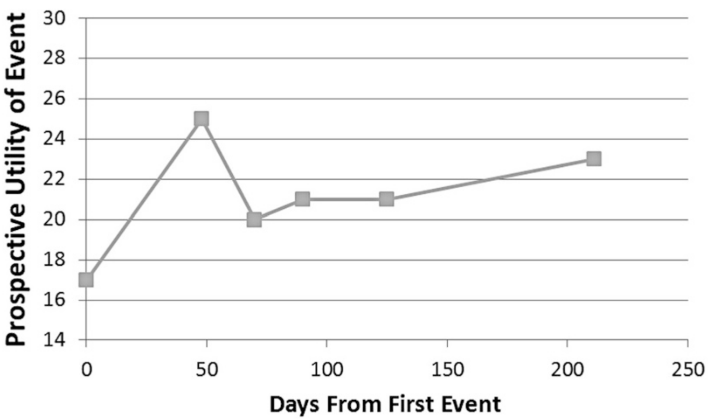


**Fig. 4.2** Optimal sequence profile with early peak, positive trend, and high last event utility. *Source: Dixon, M. J., & Verma, R. (2013). Sequence Effects in Service Bundles: Implications for Service Design and Scheduling. Journal of Operations Management, 31(3), 138–152*

A similar finding was reported by Das Gupta et al. (2016), who explored a stylized mathematical model of various impacts of event sequencing. They showed that the opposing forces of acclimation and memory decay resulted in ideal sequence profiles that were often U-shaped. Other research on optimal bundle scheduling has shown that, at least some of the time, a U-shaped profile is near optimal when considering the preferences for both early and late peaks (Dixon and Thompson 2016).

The spread effect seems to occur when there are multiple high valence moments to be considered in a sequence. For example, when Loewenstein and Prelec (1993) asked participants for their preferences of sequences of dinners over several weeks, they found that when only one exciting dinner occurred, most people preferred to split up the mundane dinners. However, when two exciting dinners were introduced, participants preferred to spread the dinners out between the beginning and the end. Additionally, Thaler (1985) found that people prefer to segregate gains and combine losses (see also Sivakumar et al. 2014). In other words, a sequence with two high positive valence moments will have a better rating compared to a sequence with only one high positive valence moment even if the valence of that one moment is equal to the sum of the valence for the two moments. By separating positive moments in time, the segregation is more easily maintained cognitively, resulting in higher overall affect.

Thaler and Johnson (1990) demonstrated this by asking participants to choose between winning two lotteries in 1 day or winning two lotteries separated by 2 weeks. A majority of the participants said that winnings that were separated would bring more happiness. Similarly, major attractions at amusement parks are often geographically separated from one another to invoke, through physical distance, some spreading out of major elements of a visitor's experiences.

Memory researchers also understand the importance of the beginning and the end of experiences. For example, the well-known primacy and recency effects have been shown to influence the memory of patients in cognitively challenging activities (Ebbinghaus 1913; Miller and Campbell 1959). Distinct from what has been previously discussed in the chapter, these temporal effects seem to be present regardless of the saliency of the moment, that is, the importance of beginning and end moments seems to be present even if that moment is not a highly salient peak.

In summary, service providers could capitalize on the benefits of early and late peak placement strategies by considering the spread effect (i.e., service bookend) strategy that places high valence moments both at the beginning and the end. Theoretical explanation of the spread effect is based on the conflicting effects of experience acclimation and memory decay and of the memory enhancing elements of the first and last moments (i.e., primacy and recency). When a service provider has multiple positive valance moments, research suggests that spreading these moments out is preferred over combining the moments, while the opposite is true for multiple negative valence moments.

### 4.4.3 End Effect

Fredrickson and Kahneman (1993) found early evidence that global evaluations can be largely predicted by the peak and end moments. The commonly-referred-to "peak-end rule" has since been found in a myriad of different contexts (e.g., Do et al. 2008). One obvious way to maximize the peak-end effect is to purposefully schedule peak moments at the end of an experience. However, the end effect often becomes an important aspect of global evaluations regardless of the ending moment's saliency (i.e., whether or not it is a peak moment). People also tend to act differently when they feel like they are entering the end of an episode or experience particularly when it is a social ending that has symbolic value (Fredrickson 1991). For example, college students facing graduation (Fredrickson 1995), people with terminal illnesses (Carstensen and Fredrickson 1998), and people considering cross-country moves (Fredrickson and Carstensen 1990) have all been shown to make different decisions when they are reminded of the upcoming end.

Furthermore, the end effect may become even more prominent in experiences where there is a goal associated with the end. For example, in research within a queuing context, participants' evaluation of the queuing experience was dominated by the end of the experience and not the peak (Carmon and Kahneman 1996). When the end of an experience revealed a concluding factor of a narrative, the end effect was also very dominant (Hui et al. 2014). Similarly, in contexts where the end was not especially meaningful, a decrease in the end effect and increase in the importance of peak effects has been found. For example in the last part of a meal (Rode et al. 2007), or the last part of a day (Miron-Shatz 2009).

When the end of an experience is unknown (i.e., the bounds of the conclusion of an experience is open-ended), the end effect is better described as a recency effect and seems to have less importance to global evaluations. In relationships that appear to be ongoing, the evaluation associated with the most recent aspect of an encounter doesn't correlate strongly with global evaluations (Fredrickson 1991, 2000). For example, the end effect has been shown to have less of an impact on the evaluations for individual television shows of serial dramas for which conflict continues throughout the season compared to procedural dramas in which conflict is resolved in each episode (Hui et al. 2014). Therefore, implying that end effects have less importance within episodic aspects of longer, larger sequences. Within the context of service relationships, this might imply that a one-time visitor to an amusement park will experience the sequence of events differently than would a season ticket holder who will experience multiple days at the park. Service providers considering the sequence of a season ticket holder may want to consider elements of sequencing across the entire season and not just within each day.

In summary, service providers should consider the impact of the end moment especially when there are clear bounds on the customer experience or when the end has some concluding goals. In addition to the ordering of events, another temporal issue considered in research is the perceived duration of the sequence. This is covered in the next section.

### *4.4.4 Duration*

The relative importance of the length of the sequence itself also has interesting implications (e.g., Ariely 1998; Fredrickson and Kahneman 1993; Varey and Kahneman 1992). Schreiber and Kahneman (2000) state that the duration of a sequence has an additive extension effect rather than a multiplicative effect, meaning that people might use duration to add or subtract from their evaluation, but only as a secondary means of evaluation. For example, an amusement park guest might say about an attraction, "That was a great ride, and it felt like we were in there for a long time too." Therefore, being a "long ride" did not directly influence the "greatness" of the ride, but did add to its evaluation.

Some studies, however, have shown that the duration of a sequence was uncorrelated with evaluations. For example, in considering the evaluation of another person's discomfort, the overall trend of discomfort was important, but the duration much less so in comparison (Varey and Kahneman 1992). Additionally, in affect-inducing films, the duration of the film had no influence on retrospective evaluations (Fredrickson and Kahneman 1993). Researchers have also found evidence of duration neglect in the sequencing of a meal (Rode et al. 2007). In particular, the length of time spent on participants' favorite component of the meal did not significantly impact the global evaluations of the meal. Another study found that evaluations of holiday vacations did not improve for longer stays (Kemp et al. 2008).

As a follow up to the reviewed research on duration neglect, it is important to note that this would imply that people do not mind if pleasant experiences stop or if painful experiences continue. Given that many of these studies were in non-service contexts for which there was no real peak (i.e., the duration could be extended without really changing any contextual elements of the experience—the experiences were relatively unchanging throughout the entire duration) and performed in laboratory settings, it is not known how these results may hold in dynamic service settings that reflect varying degrees of experienced utility.

In summary, the duration of a sequence could have an additive, extension effect on the perceived experience. However, other studies have suggested that customer evaluations are uncorrelated with the duration of a sequence. Further research is still needed that tests the implications of sequence duration in service settings.

## 4.5 Affect-Based Service Scheduling

Behavioral science insights reviewed in this chapter can be applied to enhance customer experiences by scheduling services with affect-based principles in mind. Similar to the production of a theatrical experience (e.g., Grove and Fisk 1992; Stuart and Tax 2004; Voss et al. 2008), service providers must consider the dramatic sequence and structure when choreographing the performance (e.g., the sequence of events that take place, the high and low points, the end scene, etc.). As can be learned

from the behavioral sciences, such scheduling factors will influence how an audience responds to a theatrical performance and thus how customers will be influenced. Notably, Fisk and Grove (2010) suggested that service arts and the subsequent emotional response that are evoked based on their practices should be considered in future service science research.

Currently, service researchers are beginning to apply and test these behavioral principles in the domain of affect-based service scheduling. Chase and Dasu (2001) have prescribed service principles to enhance the customer experience, such as ending on an uptick, getting the bad experiences over quickly, and segmenting the pleasure and combining the pain. Many of these behaviorally-based service principles have universal application, but certainly, the corresponding affect will vary by types of services. For example, extended service experiences (e.g., Arnould and Price 1993) compared to encounters of a shorter duration may influence how customers respond to the reviewed effects of this chapter (e.g., peak effect, trend effect). Some services are of a one-time variety while others are more relational or include a series of transactions. Some services are goal-oriented and others are more emotion-based in nature. Some have clear boundaries marking the beginning and ending of the experience while others are more open-ended or indefinite. Still, with all these differences taken into consideration, it is hard to deny that nearly all service systems need to consider the affective nature of their scheduled offerings and operations; and thus it is important to ask the question, how will the service schedule influence customer responses such as their perceptions, emotions, and future behavior?

To illustrate how behavioral implications can be applied when studying affect-based service scheduling, two research contexts that span differing service settings are summarized. The first study used a city tour context to examine sequence effects and how different approaches for the peak event of either surprise or anticipation influenced the global evaluation of the experience by customers (Dixon et al. 2017). The second study assessed multiple years of ticket sales data from a popular concert venue to examine how sequence effects over longer spans of time impact customer assessments of service bundles (Dixon and Thompson 2016, 2017; Dixon and Verma 2013). The description of these studies are based on published work. Consequently, only a brief overview of these studies is provided and the discussion is focused on the insights gained about affect-based service scheduling. For complete details on these studies, please refer to Dixon et al. (2017), Dixon and Thompson (2016, 2017), and Dixon and Verma (2013).

### *4.5.1 Study 1: City Tour Sequence Effects (Dixon et al. 2017)*

As previously reviewed, the peak moment within a series of events has been found to influence how people evaluate the customer experience. In this study, a storyboard experiment was used to simulate a city tour with a series of five stops. One of the stops was created to be a peak (i.e., a restaurant owned by a famous celebrity that has

live music and innovative menu items) and the remaining stops were neutral in comparison. Each stop had a similar number of words describing the stop and three supporting visual images to further immerse the participant in the simulation. The sequence was manipulated by placing the peak at the beginning, middle, or end of the tour. In addition, differing peak effect strategies were tested for evoking emotion, either a surprise or anticipated peak. The result was a 3 (i.e., beginning, middle, or end peak) $\times$ 2 (i.e., surprise or anticipation) between-subjects design.

Several rounds of piloting were conducted to ensure sound experimental manipulations and interpretation. Then the storyboard experiment was launched using Amazon Mechanical Turk to recruit participants. Participants viewed the simulated city tour using the storyboard scenarios and were immediately asked for their global evaluation of the experience using affect-based measures. The study found a main effect for peak placement supporting that a later peak is preferred to an earlier one in this context. In contrast, a main effect was not found for the differing strategies of surprise and anticipation, independently. However, a marginally significant interaction effect was found suggesting that customer perceptions for the strategies of surprise versus anticipation were contingent upon the peak placement. More specifically, a surprise peak ending was preferred more by customers compared to an anticipated peak ending.

In follow-up testing, a separate set of participants viewed the same city tour. Rather than asking for their immediate response, these participants were surveyed a week later to assess their global evaluation based on what they could recall. A main effect was again found for the peak placement, with a peak ending being highly preferred relative to an earlier one. However, a main effect was also found for the peak effect strategy (i.e., anticipations vs surprise). In particular, a surprise peak was independently preferred to an anticipated one when participants responded a week after the experience; and an interaction effect was no longer present.

In summary, the strength of the end effect was empirically validated. The immediate emotional influence of a surprise peak ending was preferred to one where the delight is anticipated, and what individuals recalled a week later suggested that surprise has a stronger influence on customer emotions compared to anticipation. Although a surprise peak resonated compared to anticipation based on what individuals remember, in general, the end effect seemed to dominate as the impact of surprise was stronger the later the peak occurred. An important takeaway from this study is that sequencing and peak placement should be prioritized over efforts to evoke positive surprise (i.e., delight) or anticipation (i.e., savoring). However, the strategy of surprise impacts remembered utility more than a strategy of anticipation and a surprise peak has been shown to amplify the end effect.

### 4.5.2 *Study 2: Concert Venue Sequence Effects (Dixon and Verma 2013; Dixon and Thompson 2016, 2017)*

In a separate study, a comprehensive multi-year database of performing arts ticket sales was analyzed to see if sequence effects played a role in the repurchase behavior of season subscription ticket holders. The performing arts venue held over 300 events a year and sold tickets both as individual concerts and bundled subscription packages (approximately 40 bundles a year were offered). A relative measure of prospective utility was calculated for each event based on the revenue generated per available seat.

Bundle-level measures were calculated for each bundle across 3 years (i.e., 128 total bundles) which included sequence effect-based measures such as the utility of the highest utility event (i.e., peak effect), the last event utility (i.e., end effect), the time from the peak to the end (i.e., spread effect), and the slope of a linear regression line of the sequence profile for each bundle (i.e., trend effect). These measures were included in a series of econometric logistic regression models that predicted the repurchase probability of individual season subscription ticket holders.

The results showed that sequence effect-based measures significantly improved the statistical models and improved prediction quality even after controlling for a myriad of bundle-level and customer-level attributes. In particular, the models indicated that a customer was more likely to repurchase a subscription bundle if the last event in the current bundle was higher in utility and the peak occurred earlier in the season (i.e., an increased spread effect). Additionally, the prospective utility of the next season's last event and early peak placement in the next season increased the likelihood of repurchase. This study found that prospective-based utility measures of an event should be considered important by service providers when considering schedules and that contextual sequence effects can exist even in cases of longer duration.

In a follow-up study, Dixon and Thompson (2016) used the same context to formulate an event scheduling optimization problem with the objective of optimizing affect-based effects across all bundles of an entire season for the concert venue. Capturing all the complexities of the original context (i.e., 300 events into 40 bundles spread out across an entire year) they uncovered the challenges of affect-based optimization associated with the non-linear nature of different effects. Using a meta-heuristic optimization technique called simulated annealing, they found near-optimal solutions that fell into two patterns: short, quick sequences that optimize trend, peak, and end effects; and longer, slower sequences that capture spread effects. Importantly, in an attempt to generalize the methods and mathematical models developed, a description, shown in Fig. 4.3, was provided for the application of affect-based service scheduling in different service contexts. The opportunities listed in Fig. 4.3 showcase how these scheduling principles can be extended beyond the theme park examples highlighted within this chapter. Finally, Dixon and Thompson (2017) showed that the flexibility of event membership to bundles is less important than flexibility in event scheduling across time when considering sequence-effect-based optimization.

| Service | Event | Bundle | Datetime | Location | Time horizon |
|---|---|---|---|---|---|
| Performing arts | Individual performances | Season subscription | Date of event | Hall | Year or season |
| Guided tours | Individual attractions | Different packages | Time of day | Attraction location | Duration of the tour |
| Vacation planning | Individual days or portions | Different packages | Day of vacation | Attraction location | Length of the vacation |
| Sporting events | Individual game | Season passes | Date of event | Stadium | Season |
| Education | Individual classes | Courses | Date of class | Classroom | Length of a term |
| Healthcare | Individual treatment | Care program | Date of appointment | Provider location | Duration of treatment |
| Conferences | Individual sessions | Tracks | Time of session | Rooms | Length of the conference |
| Multi-day festivals | Individual events | Days sold individually | Time of event | Sub-venue of location | Length of the festival |

**Fig. 4.3** Key attribute examples for affect-based service scheduling across different service contexts. *Source: Dixon, M. J., & Thompson, G. M. (2016). Bundling and Scheduling Service Packages with Customer Behavior: Model and Heuristic. Production and Operations Management, 25(1), 36–55*

Both of these research descriptions offer examples of studies that have tested the application of behavioral science principles related to affect-based service scheduling. Moreover, the findings of these studies demonstrate the powerful influence that the sequence of service can have on the affective response of customers. Taken together, the findings highlight that service scheduling is an important opportunity for enhancing the customer experience.

## 4.6 Conclusion

This chapter summarized the theoretical landscape for predicting the affective response to different service scheduling strategies (e.g., early peak, delayed peak, etc.). Table 4.1 presents a synopsis of each of the reviewed effects by listing a selection of relevant references and the key insights from those studies. The hope is that scholars can leverage this conceptual overview in their research and advance knowledge on affect-based service scheduling.

In addition, studies across two service contexts were reviewed to showcase the influence of the peak effect and sequence effects on customer experiences. Research that empirically validates findings from the behavioral sciences is still relatively new in the context of service management and service scholars have called for more research (Chase and Apte 2007; Cook et al. 2002; Lemon and Verhoef 2016). Therefore, there are many yet to be explored avenues for research that build from the concepts explained within the literature review. In hopes to inspire such work, the chapter concludes by presenting ideas for future research.

First and of striking importance for study, is to outline the conditions and contexts in which different aspects of sequencing becomes more or less important. Studies to date have been context specific and more work can be done to investigate the importance of context. For example, are the performance implications of sequence effects stronger or weaker in certain service settings? What role do customer preferences play in effective sequence scheduling? Do different customers prefer different sequences at different times? Can an understanding of sequence scheduling principles impact other aspects of a service such as demand or queue management?

**Table 4.1** Synopsis of selected studies

| Effect | Selected studies | Key insights |
|---|---|---|
| Peak effect | Ariely and Carmon (2000) | Static (e.g., peak and end) and dynamic (e.g., trend and rate) features of experiences |
| | Kahneman (2000) | Global evaluations are based on moments |
| | Kemp et al. (2008) | Vacations are remembered by peak moments |
| | Kahneman et al. (1997) | Predicted, experienced, and remembered utility are functions of peak moments |
| | Loewenstein (1987), Loewenstein and Schkade (1999) | Anticipation of peak moments |
| | Brickman et al. (1978) | Habituation of peak moments changes global evaluations |
| | Fredrickson and Kahneman (1993) | Peak and end effects explain evaluations better than averages |
| Early peak placement | Frederick et al. (2002) | Time discounted theory of utility |
| | Koopmans (1960) | Impatience |
| | Knight (1921) | Uncertainty of the future |
| | Brickman et al. (1978) | Earlier peaks lead to a better outlook on the future, rose-colored glasses |
| | Feigenbaum and Simon (1962), Murdock Jr (1962) | Primacy |
| | Asch (1946) | Early impressions used a reference points |
| | Anderson and Jacobson (1965) | Inconsistency discounting |
| | Crano (1977) | Attention decrement, later moments hold less attention |
| | Kahneman et al. (1993) | Earlier negative peaks lessen bad evaluations |
| Delayed peak placement | Kahneman and Miller (1986), Loewenstein and Prelec (1993) | Get the bad over with before experiencing the good |
| | O'Brien and Ellsworth (2012), Ross and Simonson (1991) | Preference for happy endings |
| | Chun (2009), Kwortnik and Ross (2007), Shiv and Huber (2000) | Savoring the anticipation of future peak moments increases utility |
| | Kocher et al. (2014), Nowlis et al. (2004) | Preference for delayed outcomes of positive moments |
| | Frederick et al. (2002), Loewenstein and Prelec (1993), Read et al. (1999) | Preference for the timing of peak moments changes based on context and choice sets |

(continued)

**Table 4.1** (continued)

| Effect | Selected studies | Key insights |
|---|---|---|
| Trend effect | Kahneman and Tversky (1979) | Declining sequence feels like a loss, while improving feels like a gain; losses loom more than gains |
| | Hsee and Abelson (1991), Hsee et al. (1991, 1994) | Rate of change makes a difference in evaluations |
| | Ariely (1998), Chapman (2000), Dixon and Verma (2013), Hsee et al. (1991), Loewenstein and Sicherman (1991), Moya (2006), Varey and Kahneman (1992) | Upward trends are preferable in multiple contexts |
| Spread effect | Heskett et al. (1990) | Service bookends place good moments at the beginning and the end |
| | Das Gupta et al. (2016) | Decay and acclimation leads to U-shape schedules |
| | Dixon and Thompson (2017) | Sequence effects are maximized when a spreading effect is considered |
| | Ebbinghaus (1913), Miller and Campbell (1959) | Recency and primacy, the first and last things are what are remembered |
| | Loewenstein and Prelec (1993), Sivakumar et al. (2014), Thaler (1985) | Segregate positive moments and combine negative moments |
| End effect | Fredrickson and Kahneman (1993) | Peak and end effects explain evaluations better than averages |
| | Fredrickson (1991, 2000), Hui et al. (2014) | The last experience is less import in unbounded experiences |
| | Carmon and Kahneman (1996), Hui et al. (2014) | The end of an experience has importance when the end is the goal |
| | Carstensen and Fredrickson (1998), Fredrickson (1991, 1995), Fredrickson and Carstensen (1990) | The end of an experience has symbolic representation regardless of its valence |
| Duration | Schreiber and Kahneman (2000) | Duration is an additive extension effect |
| | Fredrickson and Kahneman (1993), Kemp et al. (2008), Rode et al. (2007), Varey and Kahneman (1992) | Evidence for duration neglect in various context |

Equally important would be to gain a better understanding of what elements make a series of moments into a cohesive sequence that adheres to the theoretical principles of affect-based service scheduling. For example, what underlying elements make a series of concerts into a cohesive experience as opposed to a series of independent events? As the level of perceived continuity within an experience increases so too does the importance of some of the specific affect-based service scheduling principles. Loewenstein and Prelec (1993) state that when events are separated in time, they may not be considered a sequence in the mind of research participants (see also, Ariely and Zauberman 2003). However, other research has

shown evidence of affect-based service scheduling effects in temporally distant and discrete experiences; for example, gift giving in financial services (Haisley et al. 2011), payment sequences for auto repair and vacations (Langer et al. 2005), and timing of repair services performed in a service contract (Bolton et al. 2006). One explanation for why affect-based service scheduling effects were found in these contexts even though they are temporally distant and discrete is their degree of cohesion. Miron-Shatz (2009) found that when participants were asked to evaluate a multi-episode sequence that had no apparent cohesiveness (i.e., events from the previous day), they tended to rely on simple averages rather than affect-based service scheduling effects. This research suggests that multi-episode sequences with stronger levels of perceived cohesiveness will likely have different results. Additional research is needed to identify the defining features that make a sequence cohesive and to understand the application of affect-based service scheduling strategies in complex and dynamic contexts.

In line with the systematic view of service scientists having a deep understanding in at least one discipline and broad understanding of many others (i.e., T-shaped professional) (Spohrer and Maglio 2010), future research that deepens the knowledge base on affect-based service scheduling while finding broader connections to other major service science themes is needed. For example, how does affect-based service schedule principles fit into the broader themes of system networking, value co-creation, and service dominant logic thinking?

In conclusion, affect-based service scheduling is an important service topic and an emerging area for future study. This chapter provides those interested in studying affect-based service scheduling an overview of behavioral science studies related to sequencing so it can be leveraged and applied in future service science research. Such knowledge can offer new ways of thinking about scheduling the customer experience so the affective side of service, customer perceptions, emotions, and future behavior, can be maximized.

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# Chapter 5
# Customer Acceptance of AI in Service Encounters: Understanding Antecedents and Consequences

**Amy L. Ostrom, Darima Fotheringham, and Mary Jo Bitner**

**Abstract** In this chapter, we take a customer-centric view of narrow artificial intelligence (AI), or task-specific AI applications. Because of the breadth and extent of AI applications, we limit our focus to service encounters—which are times when customers interact directly on the frontline with a service company or organization. The purpose is to illuminate the roles of AI in the context of frontline service encounters and to identify the potential benefits and negative consequences for customers of AI-supported, AI-augmented, and AI-performed services. We develop a conceptual framework of the antecedents and consequences of AI acceptance by customers grounded in previous research, theory, and practice. Previous research has examined the adoption of self-service technologies (SSTs) and established that innovation characteristics and individual differences predict role clarity, motivation and ability (RMA), which in turn predict adoption of SSTs (see Meuter et al. 2005; Blut et al. 2016). However, we believe that additional antecedents will come into play in predicting the acceptance of service encounter technologies tied to AI. Therefore, we expand the relevant set of antecedents beyond the established constructs and theories to include variables that are particularly relevant for AI applications such as privacy concerns, trust, and perceptions of "creepiness." We also examine a broader set of potential consequences of customer acceptance of AI including what customers may experience (e.g., more personalized service encounters) and how AI may affect customers (e.g., lead to increased well-being due to more access to services). The chapter concludes with research questions and directions for the future tied directly to the conceptual framework.

**Keywords** Artificial intelligence (AI) · Service encounter · AI-enabled service · Technology acceptance · Service technologies

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_5

## 5.1 Introduction

Customer-focused artificial intelligence (AI) applications in service industries are exploding. Their prevalence is obvious in retail, financial, health care, education, transportation, and communication industries. For example, there is already wide acceptance of AI-based personalization algorithms in retail (e.g., Amazon's personal recommendation tool), and patients seem willing to have their doctors consult AI-enabled databases to bring in a wider range of opinions on their medical case. It is clear that all service industries are subject to change (potentially radical change) and ripe for innovation in their business models, offerings, and processes based in AI. While not all AI applications are widely adopted or successful, their development and ultimate impact—for good or bad—are inevitable.

There is no shortage of reports, articles, books, and webcasts on the subject of AI and its impact on business strategy. Consulting firms such as Forrester (Artificial Intelligence with the human touch: Blend AI with human agents to improve both customer and agent satisfaction 2017) and McKinsey (Bughin et al. 2017), companies such as Microsoft (Microsoft Corporation 2018), U.S. government agencies (National Science and Technology Council 2016), and trade publications such as *Time* special edition (Gibbs et al. 2017) have recently published reports on the topic. Books have been written on AI's impact (e.g., Tegmark 2017). Academic articles across business disciplines, while still relatively few in number, address the AI issue narrowly (e.g., service robots, see van Doorn et al. 2017) and more broadly (e.g., all human jobs being replaced by AI, see Huang and Rust 2018). With few exceptions, most of the published work to date focuses on the technology itself, changing business models, the impact on organizations' bottom line, changing nature of service jobs, and opportunities for firm growth and innovation through AI applications. There is less focus currently on customer or end-user impacts of AI or on predicting which applications will be accepted and which will not and why, particularly at the level of a specific service encounter, or frontline interaction (for exceptions see Juma 2016; Leung et al. n.d.). The relentless march of AI often seems to be anchored on technology advancements without necessarily considering human or customer acceptance or the impact on customer well-being, or even broader ethical issues.

Thus, to address this perceived gap in current understanding, we take the customer's point of view in looking specifically at how and why customers embrace or resist narrow, task-based AI applications in service encounters. We identify the roles of AI in the context of service encounters and we present a conceptual framework, based on prior research, practice and theory, to explain customer acceptance of AI in service encounters. The framework expands the set of antecedents to AI acceptance beyond established constructs and theories related to technology acceptance to include AI-specific variables such as privacy concerns, trust, and perceived "creepiness." We also examine a set of potential consequences of customer acceptance of AI including more personalized service encounters, enhanced customer capabilities, time savings, and greater well-being, along with the loss of privacy, greater isolation, and other negative consequences. The chapter concludes with research questions tied to the framework that are meant to serve as a catalyst for future work.

## 5.2 Conceptual Background and Definitions

### *5.2.1 Service Encounters and AI*

While AI can and does influence individual service offerings and service systems in many ways, here we isolate our focus to the role and acceptance of AI within service encounters and service experiences where individual customers interact with companies to receive or cocreate value. For example, we include within our purview hospitality robots that perform services in place of employees in hotels, medical decision support systems that help doctors diagnose a patient's condition during a medical visit, or machines that perform elements of the service such as robotic surgeries guided by a doctor. Although it is intriguing and very important, we do not focus on AI that is internal to an organization's support processes or AI that collects and analyzes data for the company, unless it is used directly to assist and interact with customers during a service encounter.

We focus on service encounters because they are a central construct within service management that has been shown to drive critical service outcomes such as customer satisfaction, repeat purchase, and loyalty (Bitner and Wang 2014; Gupta and Zeithaml 2006). The service encounter was defined early on as "the dyadic interaction between a customer and a service provider" (Surprenant and Solomon 1987, p. 87), which is the moment in time when a customer interacts directly with a service provider. Also prevalent at the time was a definition provided by Shostack (1985, p. 243), who had a broader view of the service encounter construct and described it as "a period of time during which a consumer directly interacts with a service." Consistent with the time period when these definitions were put forward, both were very human-centered and focused on personal dyadic interactions.

Over time, human service encounters became viewed as the "face" of the organization and the drivers of customer interaction outcomes and customer satisfaction. Empirically, research demonstrated over and over the impact of service encounter outcomes on customer satisfaction and overall perceptions of service quality (e.g., Zeithaml et al. 2017, 1996; Gupta and Zeithaml 2006; Cronin Jr et al. 2000). As technology has become more and more prevalent in the service encounter, the idea that personal encounters are the "face" has become blurred, and customer interactions are no longer always (or even often) in the form of personal or face-to-face interactions. Many service encounters now occur online, over the phone, or more recently through AI applications. Thus, a new, contemporary definition of a service encounter has been proposed as "any customer-company interaction that results from a service system that is comprised of interrelated technologies (either company- or customer-owned), human actors (employees and customer), physical/digital environments, and company/customer processes" (Larivière et al. 2017, p. 239). We ascribe to this newer definition of the service encounter and its implications, simplifying it to mean "the times when customers interact directly on the frontline with a service company or organization." AI within service encounters thus refers to any AI application that directly influences the customer's interactions with the service company or organization in any form.

### 5.2.2 AI Defined

The term "artificial intelligence" is attributed to John McCarthy, commonly acknowledged as the father of AI, who coined the term in the middle of the last century (Buchanan 2005). In a talk at Dartmouth College in 1956, he defined AI as "the science and engineering of making intelligent machines" (McCarthy 2007). McCarthy went on to lead research and scientific advances in AI at both M.I.T. and Stanford where he founded the Stanford Artificial Intelligence Laboratory and continued to lead and contribute to AI science until his death in 2011. While more detailed definitions of AI have been proposed through the decades, there is no one definition that everyone ascribes to. In fact, current publications on AI typically do not define the concept at all, but rather discuss specific types of AI and/or application examples. For example, in its brochure, the Stanford Artificial Intelligence Laboratory (SAIL, ai.stanford.edu) describes current AI as including: robotics, natural language processing, machine learning, computer vision, genomics, and autonomous vehicles.

At its most basic level, AI can be defined as "non-biological intelligence" (Tegmark 2017, p. 39) or "applying to any technique that enables computers to mimic human intelligence using logic, if-then rules, decision trees, and machine learning" (Gibbs et al. 2017, p. 7). Useful for our purpose is the general distinction between "narrow AI" and "general AI," where the former is defined as "ability to accomplish a narrow set of goals, e.g., play chess or drive a car" and the latter is defined as "ability to accomplish any goal, including learning" (Tegmark 2017, p. 39). For a more detailed discussion of AI, narrow AI, and general AI, see National Science and Technology Council (2016).

### 5.2.3 AI Roles in Service Encounters

The different roles of narrow, or task-specific, AI in service encounters are captured by Fig. 5.1 where the actors in service encounters are depicted and the roles of AI as supporter, augmenter, or service performer are shown. While others have discussed broadly the roles of technology in service encounters (e.g., Meuter et al. 2000; Marinova et al. 2017; Larivière et al. 2017), here we focus specifically on AI roles.

In the first row, AI is shown as a supporter of the service encounter ("AI Supported"), working behind the scenes to support the frontline service employee (FLE) in providing him/her with information, aiding in decision making or assisting with customization of the service. In these cases, the FLE is still the actor who performs the service and/or directly interacts with the customer; however, the FLE is being supported and in some cases even directed by AI in real time during the interaction with the customer. The second row of Fig. 5.1, shows AI as an actor in the service encounter, interacting directly with the customer and/or visibly assisting the FLE, augmenting the traditional encounter with enhanced information or new,

| Type of Service Encounter | Examples |
|---|---|
| AI Supported<br>C ↔ FLE<br>↕<br>AI | • IBM Watson used by physicians to help with patient diagnosis<br>• InnerEye, an AI system to help oncologists recognize tumors vs. healthy tissue<br>• AI tools that recognize customers' emotions and provide suggested actions to frontline employees<br>• Positive train control that alerts train conductors and controls the speed of a train in real time |
| AI Augmented<br>C<br>↙↗ ↖↘<br>FLE ↔ AI | • Robot-assisted surgery<br>• Nurse and care-providing robots collaborating to assist patients<br>• Real-time language translation |
| AI Performed<br>C ↔ AI | • Chatbots used in a variety of contexts (e.g., Woebot to improve mental health; AI concierges at hotels; Microsoft's chatbot companion XiaoIce)<br>• Carebots (e.g., robots to help the elderly)<br>• Hotel robots at check-in or to deliver items to guests' room<br>• Virtual assistants (e.g., Alexa, Siri, Cortana)<br>• Autonomous cars<br>• Drone-delivered packages |

C – Customer
FLE – Frontline Employee
AI – Artificial Intelligence

**Fig. 5.1** Types of AI-enabled service encounters

innovative services. We refer to these types of encounters as "AI Augmented." The third row of Fig. 5.1 illustrates "AI Performed" service encounters where AI is the actor interacting directly with a customer to cocreate and/or deliver the service directly to him/her. In these cases, AI substitutes completely for an FLE in a traditional service or AI performs a brand new service that FLEs were never even capable of performing. Examples of each type of AI encounter are also included in the figure.

## 5.3 Customer Acceptance of AI in Service Encounters

Our focus is on understanding and theoretically explaining customer acceptance of AI in service encounters. We also look at consequences, both positive and negative, of AI acceptance by customers. These antecedents and consequences are shown in Fig. 5.2 and discussed in detail in the following sections. Here we provide a brief overview of the framework.

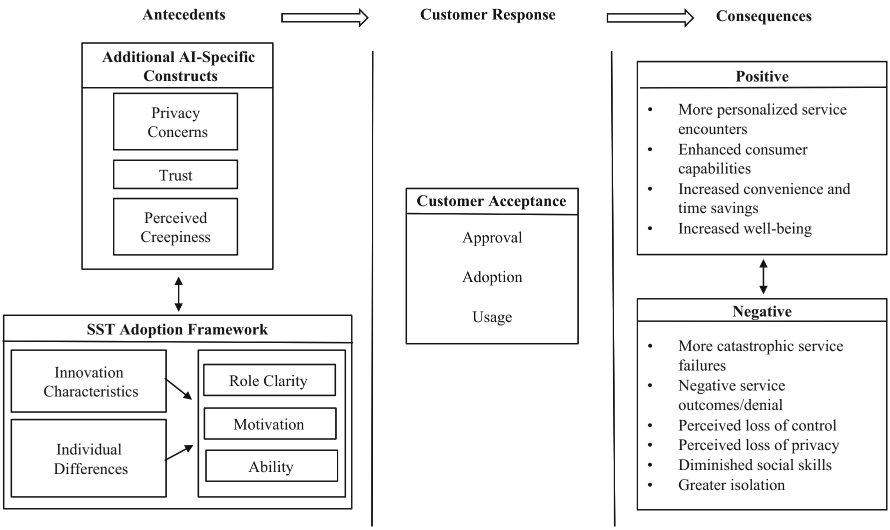


**Fig. 5.2** Customer acceptance of AI in service encounters

Central to our framework is the idea of "Customer Acceptance" of AI. We consider this term broadly to span everything from basic approval (enthusiastic liking or even reluctant appreciation), to adoption (actual decision to try whether by independent choice or forced), to usage (continued usage, whether enthusiastic or reluctant). We deliberately include several types of acceptance to leave the door open for research on any one of them.

The proposed theoretical antecedents of AI acceptance are shown on the left side of Fig. 5.2. Previous studies have empirically investigated the antecedents of self-service technology (SST) adoption (Meuter et al. 2005), and we include the key variables from this theoretical framework in our model. In their work, Meuter et al. demonstrate that customer adoption of SSTs is influenced by customer role clarity (do they know how to use the SST and what to do?), motivation (is there a reason to use the SST that would propel the customer to try it—or "what is in it for me?"), and ability (do they have the resources and ability to use the SST?). These core constructs are influenced by the characteristics of the technology itself and by customers' individual differences. Later, a meta-analysis of SST acceptance illustrated the complexity of variables that interrelate to influence SST acceptance (Blut et al. 2016).

Beyond what is already known about SST acceptance, we believe that acceptance of AI in service encounters will depend on other AI-specific variables beyond those traditionally studied in SST research. Included in this set of variables are: privacy concerns, trust in the technology and company, and perceptions of "creepiness" of the technology.

Although not an exhaustive list, we also explore both positive and negative consequences of AI acceptance by customers (e.g., what effects may customers experience as companies and organizations implement AI as part of service

encounters and customers adopt, accept, and utilize it). Here we focus on potential consequences such as time savings and increased well-being on the positive side, and loss of privacy and greater isolation on the negative side. In the following sections, we expand on the antecedents and consequences shown in Fig. 5.2.

## 5.4 Antecedents of Customer Acceptance of AI in Service Encounters

We turn to the self-service technology (SST) adoption framework as a starting point of our discussion of the drivers of AI-based technology acceptance in services. The SST adoption framework suggests that adoption of SSTs depends on the following factors: innovation characteristics of technology, individual differences of consumers, role clarity, motivation, and ability (Meuter et al. 2005). While these antecedents remain relevant in the context of AI-based technology services, we expand the framework by broadening the scope of the established antecedents and by introducing additional antecedents that gain relevance in the context of AI-enabled services.

### *5.4.1 Innovation Characteristics*

Meuter et al. (2005) investigate the following innovation characteristics that impact consumers' decision to try and consequently adopt new technology in the context of a service encounter: compatibility, relative advantage, complexity, observability, trialability, and perceived risk. These predictors will retain their relevance in the context of AI-enabled services. Consumers will evaluate the new technology, whether it is enabled by AI or not, on its compatibility with consumers' values and lifestyle. Because narrow AI can easily outperform humans on specific tasks, consumers can be willing to accept an AI-based technology that is consistent with their values and improves their lifestyle. However, in cases when an AI is viewed as a disruptor, potentially taking away from consumers' experience or going against consumers' values, the AI-based technology will likely be rejected. For example, recent research by Leung et al. (n.d.) showed that consumers resist automation features when "these features hinder the attribution of identity-relevant consumption outcomes to oneself." The researchers found that consumers were less likely to adopt automation features that replaced activities relevant to consumers' identity, such as cycling enthusiasts rejecting electric bikes (Leung et al. n.d.). These findings are consistent with lessons from the history of technology innovation. Drawing from over 600 years of history of technology and innovation, Juma (2016) argues that new technologies are more likely to be rejected when they are perceived as a threat to what people see as being human, technology that intends to replace people's humanity rather than augment it.

Perceived risk is another characteristic that will play an important role in consumers' acceptance of new technology. Consumers will evaluate the potential risks to benefits ratio of using an AI-based technology. Privacy concerns, for example, can increase the perceived risk of using personalized services, creating a potential barrier to adoption (Awad and Krishnan 2006). In the contexts where the stakes of the service encounter outcomes are especially high, such as health care diagnostics or use of self-driving cars, the complexity of AI machine learning algorithms, which cannot be understood or explained by their creators, can further inhibit acceptance of AI-based technology (Knight 2017).

### 5.4.2 Individual Differences

The SST adoption framework suggests that such factors as "inertia, technology anxiety, need for interaction, previous experience with related SSTs, and demographic characteristics" will influence consumers' trial of SSTs (Meuter et al. 2005, p. 66). We expect that these individual differences will also determine consumers' likelihood to approve, adopt and use AI-based technology in service encounters. For example, according to a 2017 study by Genpact, younger consumers are more likely to use AI and twice as likely to indicate that AI has a positive effect on their lives (Genpact 2017).

Interestingly, the recent PwC's Global Consumer Insights Survey shows that Asian consumers are more willing to use and purchase AI-based technology for personal use (PwC's Global Consumer Insights Survey 2018). This finding raises the question of whether there may be some cultural or regional factors in addition to individual characteristics that deserve consideration when it comes to the acceptance of AI-based technology.

### 5.4.3 Clarity of Customers' and AI's Roles

Unlike SSTs, AI-based technology can also act as an independent agent with or without the users' awareness of the AI's actions (Hoffman and Novak 2017). For example, Google's spam filters, one of the first applications of AI, detects and blocks 99.9% of spam and phishing messages without any input from users (Lardinois 2017). Facebook has recently introduced an AI-based suicide prevention tool that flags users expressing suicidal thoughts and offers them support, such as suggestions to reach out to friends and family or contact a helpline, and provides information about available help resources (Rosen 2017). In this context, the concept of role clarity must be expanded to include clarity of both the customer's and the AI's role in the service process. During an encounter with an AI-enabled technology, the customer should understand what both sides are contributing to the coproduced service. The clarity of roles is important from two perspectives, (1) establishing the

division of responsibilities in a coproduced service and (2) facilitating customers' trust in the technology through transparency.

Achieving the desired outcome of a service will depend on both actors (the customer and the AI), performing their parts according to the design. Role clarity is critical for the successful integration of the customer's and AI's inputs. It ensures customers' understanding of which steps in a service encounter are designed to be performed by the AI and which by the customers for a seamless service performance. Misunderstanding or lack of role clarity can lead to unsatisfactory and, when the stakes are especially high, even tragic results. For example, the 2013 Asiana plane crash in San Francisco was a disastrous outcome due, in part, to insufficient role clarity. The pilot, relying on the plane's autopilot, mistakenly expected that the auto-throttle system would be able to come out of the idle position on its own when the plane started losing speed, an apparent misunderstanding of the division of the roles between the pilot and the auto-throttle system during a critical moment (Souppouris 2013). While this issue involved AI and a FLE, one can imagine customers experiencing their own lack of role clarity when AI is involved such as in the context of autonomous vehicles. What activities will the AI-enabled vehicle take on and what will the customer still have to do?

Role clarity can also signal transparency about the nature of the encounter, which serves as a foundation of trust (Hengstler et al. 2016). With AI's ability to act as an independent agent, the level of transparency of AI's role in an encounter can influence customers' trust in the technology. Not fully disclosing the role of the artificially intelligent agent and its actions during and after the encounter can erode consumers' trust in the technology and the service provider. In this context, role clarity can extend to include questions related to what data the AI collects during the interaction and how it uses the data during and after the encounter. Amazon made news when it was ordered to submit audio recordings made by a personal Echo device as evidence in a criminal investigation (Heater 2017). Many consumers were surprised and alarmed to learn that their Alexa had been recording and storing audio even when not activated by the device owners. Unroll.me, a free service intended to help consumers to unsubscribe from email subscription lists, is another example of lack of transparency, which caused a consumer backlash. Consumers were infuriated when they found that Unroll.me was scanning users' emails and selling the insights to third parties (Isaac and Lohr 2017). Such cases where customers lack clarity about AI's role raise concerns about data privacy and create barriers to adoption of AI-based technology.

### 5.4.4 Consumers' Motivation to Adopt AI-Based Technology

AI-based technology can offer tremendous value to consumers by enhancing convenience, efficiency, and speed of service, thereby increasing consumers' motivation to accept, adopt and use such technology. We enjoy having relevant information readily available, whether it is Alexa updating us on pertinent news, or Google

Assistant reminding us about our upcoming meetings and providing travel time estimates based on real-life traffic data. AI that powers these products allows firms to personalize service features to individual needs by continually learning from the interaction data that these products collect. For example, a consumer can set the Nest thermostat schedule, but as Nest gains insights into the household and identifies relevant behavior patterns, it will take an independent action to fine-tune the initial schedule to optimize energy efficiency, while adhering to the consumer's temperature preferences.

While AI-enabled technology can be helpful in carrying out useful tasks, unlike most SSTs, AI-powered technology can also be a source of enjoyment and fun, providing hedonic value to the users. Think of Alexa cracking jokes or playing your favorite tune, or Microsoft's XiaoIce, a chatbot app that mimics human interaction with an intent to become a person's virtual friend. Since XiaoIce's introduction in China, this friendly and intelligent chatbot with personality has captured the hearts of millions of Chinese users (Markoff and Mozur 2015). According to Agarwal and Karahanna, cognitive absorption is an important variable of intrinsic motivation in the context of adoption of hedonic technology (Agarwal and Karahanna 2000; Lowry et al. 2013), which could explain why XiaoIce users are so taken by the chatbot.

### *5.4.5 Consumers' Ability in the Context of Adoption of AI-Based Technology*

Within the SST framework, ability referred to consumers' ability to perform the steps involved in an interaction with an SST. There is a need to broaden this construct in the context of AI-enabled service encounters. For example, voice-enabled AI devices have a potential to remove technological barriers, making interaction with technology more accessible regardless of customers' technical skills. At the same time, customers may evaluate the role of AI-enabled technology by the degree to which it enhances or potentially limits customers' perceived abilities within the context of a service encounter. For example, customers can see AI as an amplifier of their cognitive or physical abilities, enabling them to improve service outcomes through integration of human and AI capabilities (Wilson and Daugherty 2018).

While AI has a potential to democratize services by making them more accessible, the opposite can also be true. Lack of technical expertise or adequate financial resources may prevent consumers' access to AI-based technology, therefore, limiting its adoption. For example, recent PwC's Global Consumer Insights Survey showed that early AI adopters tend to be tech savvy and less price conscious compared to non-adopters (PwC's Global Consumer Insights Survey 2018).

### 5.4.6 Privacy Concerns Related to the Use of AI-Based Technology

We can compare the success of Microsoft's XiaoIce to the failure of Tay, Microsoft's U.S.-based AI chatbot, which was launched as a social bot on Twitter. Microsoft had to take Tay down soon after the launch because, learning from its interactions with other Twitter users, the bot quickly moved into discussing divisive, politically and racially charged topics (Hunt 2016). The failure of Tay and success of XiaoIce demonstrate that both quantity and quality of the data collected from the interactions are critical for training and achieving high-level AI performance. Users have to be willing to share their personal information to benefit from personalization, which leads to the personalization-privacy paradox (Awad and Krishnan 2006; Lee and Rha 2016). Consumers have to find the right balance between maximizing benefits of personalized services by being more open with their personal data and minimizing privacy risks by limiting disclosure of their personal data.

According to a study by Genpact that surveyed 5000 respondents in the U.S., U.K., and Australia, privacy concerns are one of the main obstacles to consumer adoption of AI-based solutions (Genpact 2017). Over 50% of the survey participants indicated that "they are uncomfortable with the idea of companies using AI to access their personal data," while 71% said that "they don't want companies to use AI that threatens to infringe on their privacy, even if it improves the customer experience" (Genpact 2017, p. 12).

At the same time, research shows that, while privacy considerations and perceptions of privacy risks negatively influence consumers' willingness to use personalized services, the value of the personalized service can outweigh privacy-related concerns (Awad and Krishnan 2006). Furthermore, research by Lee and Rha (2016) in the context of location-based mobile commerce suggests that consumers' perception of privacy risks can be mitigated by increasing the level of trust in the service provider. Trust, therefore, becomes another critical factor that affects consumer acceptance of AI-based technology.

### 5.4.7 Consumers' Trust in AI-Based Technology

When discussing consumer trust with regard to AI-based technology, we can draw from extant research in automation and human interaction. In the context of automation, Lee and See (2004, p. 51) define trust as the "attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability." Both social psychology and marketing relationship literature identify uncertainty and vulnerability as critical characteristics that activate trust in interpersonal and organizational relationships. In a service encounter, inability to control the actions of the service provider brings the element of uncertainty, while the outcomes of the encounter directly affect the customer, which introduces the element of

vulnerability. Trust is especially critical in the early stages of relationships, which is the case with new technology adoption when the situation is ambiguous, and outcomes are uncertain. According to Lee and See (2004), trust is what bridges the distance between individual's beliefs about the characteristics and capabilities of automation and the individual's intention to use and rely on automation.

In the context of eCommerce, Pavlou (2003) distinguishes between two facets of trust, trust in the provider and trust in the transaction medium. This differentiation will also apply in the context of AI-enabled service encounters, where both trust in the service provider and trust in the specific AI technology will contribute to customers' trust toward the AI-enabled service.

Mayer et al. (1995) identified three key factors that determine organizations' trustworthiness: ability, integrity and benevolence. Ability refers to domain-specific expertise, skills, and competencies relevant to the service interaction. Integrity assesses whether the customer finds the principles followed by the provider to be acceptable. Benevolence relates to alignment between the motivation and intentions of the provider and those of the customer. Recent events involving Facebook and Cambridge Analytica exposed Facebook's business model that had an inadequate level of integrity and benevolence in the eyes of Facebook's users whose data was harvested without their awareness or consent (Rosenberg and Frenkel 2018). These events resulted in a sharp decline of public trust in Facebook (Weisbaum 2018).

In the context of automation, Lee and See (2004) define performance, process and purpose as the basis of trust. Performance (the What) is similar to ability and refers to the functionality of the technology, whether it performs in a reliable, predictable and capable way. Process (the How) is the extent to which the AI-enabled technology is appropriate for the service encounter and is able to achieve the customer's goals. Purpose (the Why) is related to benevolence and refers to why the technology was developed and whether it performs according to the designer's intentions.

Consumers will evaluate ability, integrity and benevolence of the service provider and performance, process, and purpose of the AI-enabled technology based on their experience before, during and after the encounter. These factors will collectively contribute to developing a level of trust in the new AI-enabled service. The stability or volatility of trust will depend on how many of the contributing factors are perceived as trustworthy by the customer (McKnight et al. 1998).

In the context of AI-based solution adoption in business-to-business services, Hengstler et al. (2016, p. 113) found that the "transparency of the development process and gradual introduction of the technology are crucial strategies" for fostering trust in the innovative firm. Companies may be better off introducing new capabilities gradually, in a series of steps that engage customers' curiosity and desire for novelty, instead of doing it in one big leap that may alarm customers and come across as too big of a departure from more traditional service delivery alternatives.

### *5.4.8 Perceived Creepiness of AI-Based Technology*

While customers may appreciate personalized interactions delivered by AI and find them helpful, such interactions, if not done well, can come across as intrusive and creepy. Most commercially used AI is narrow in its application, usually designed with a goal to optimize a specific performance. However, optimization without consideration for social norms and understanding of consumer psychology can potentially cross the line of what consumers perceive to be acceptable. The example of Target's algorithm sending personalized coupon offers for baby items to a pregnant teenager whose parents had no idea about the pregnancy is a good illustration of how an algorithm designed for optimization without consideration for social norms can backfire (Ellenberg 2014). Behavior of AI-enabled applications that is in conflict with what is considered to be an acceptable social norm can be perceived as creepy (Tene and Polonetsky 2014). Tene and Polonetsky (2014) identify three potential types of conflicts: creepy behavior that goes against traditional social norms, creepy behavior that demonstrates a gap between the norms of developers and the public at large; and in other instances, the creepy behavior may be moving into unchartered territory, where social norms are yet to be established.

Companies admit that they often struggle to find the line between being helpful and creepy, yet they often push the envelope of what is acceptable, empowered by new technological capabilities. We can use the lessons from industrial design to shed light on this issue. The wisdom of Raymond Loewy, who is widely considered to be the father of industrial design, is still highly relevant today. He understood the conflict between product developers' desire to push technological boundaries and consumers' reluctance to accept the most advanced products: 'Our desire is to give the buying public the most advanced product that research can develop and technology can produce. Unfortunately, it has been proven time and time again that such a product does not always sell well' (Loewy 1951, p. 277).

Loewy outlined his insights in the MAYA (Most Advanced Yet Acceptable) principle that reflects a consumer psychology paradox: consumers are torn between their curiosity and attraction to the new and their resistance and aversion to the unfamiliar (Loewy 1979). Loewy (1951, p. 277) believed that, "the adult public's taste is not necessarily ready to accept the logical solutions to their requirements if the solution implies too vast a departure from what they have been conditioned into accepting as the norm." While there is a temptation to explore and exploit the advancements of AI-based technology in new ways, it is useful to consider how far these capabilities depart from the accepted norms of the specific service context.

## 5.5 Consequences of Customer Acceptance and Usage of AI

As is true with most, if not all, new technology, both positive and negatives outcomes may result from the use of AI within the context of service encounters and services more broadly. The scope and scale of each will depend on decisions made

by companies that create and those that implement AI, the laws and regulations put into effect that govern AI usage, as well as how consumers react to and use AI-supported, AI-augmented, and AI-performed services individually and collectively. In the paragraphs that follow, some of the key potential positive and negative consequences for consumers that may result from AI acceptance and usage are discussed.

## *5.5.1 Positive Consequences*

Several important positive outcomes are expected to accrue to consumers with greater advances in narrow AI. Some of these we are already experiencing at a small level today, yet their effect will be substantially heightened as innovation of AI technology continues and as AI-based services are more broadly adopted. Below we highlight four key benefits for customers due to AI-enabled service encounters: more personalization leading to richer, more satisfying experiences, enhanced consumer capabilities, increased convenience and time savings, as well as increased consumer well-being.

### 5.5.1.1 More Personalized Service Encounters

One key positive benefit with the adoption of AI will be better, more enriched, personalized service encounters that are likely to lead to not only greater satisfaction and time savings but also, in some circumstances, greater consumer well-being. Greater personalization may arise from AI-supported service encounters, AI-augmented encounters, as well as AI-performed services in virtually all industries. Three industries where the effect of AI will be substantial include retail, education, and health care. In terms of retail, AI is already commonly used to personalize websites as well as provide personalized product recommendations (e.g., Amazon and Netflix) as noted earlier, leading to greater satisfaction and time savings. Stitch Fix, an online styling service, relies on a collaboration between human stylists and AI to determine the right style and items for its customers that fit their budget and lifestyle. The AI analyzes customer preferences, body measurements, and style trends, providing a refined list of recommendations to the stylists to choose from. These more personalized matches lead to increased customer satisfaction and a lower return rate (Marr 2018). In China, KFC, working in collaboration with Baidu, is piloting a facial recognition technology that scans a customer at a restaurant kiosk and, based on her estimated age, gender, facial expressions and other characteristics, recommends menu items. The customer's face scan is retained so that when she returns, it can provide recommendations based on her order history (Etherington 2016). It appears that a substantial amount of new AI being implemented in the context of service encounters is focused on enabling greater personalization. In the future, when service failures occur, in retail and in other

industries, AI should also enable more personalized service recovery, where data can be used to determine all options that exist to make it right for the customer as well as better tailor the nature of the recovery to the customer's preferences.

In education, adaptive learning is already used by "capturing information about what each student knows and crafting custom lesson plans based on individuals' knowledge and progress. . .to deliver the right content, at the right time, in the best way for each student" (Bughin et al. 2017, p. 30). In the future, advances in AI will be able to capture and analyze facial expressions and eye movement, along with digital and group interactions, leading to an even greater ability to assess, engage, and coach students in real time (Bughin et al. 2017). For example, Packback Questions' algorithms help advance students' experiences with online discussion boards by coaching "students to improve responses and to ask more thought-provoking questions, sparking better discussion and critical thinking. Packback also provides recommendations to faculty on how to further improve student engagement" (Craig 2018). Georgia Tech has already experimented with teaching assistant bots that have led to increased student engagement (Maderer 2017).

In health care, AI technologies are being used by companies to design personalized cancer treatment plans (e.g., Turbine), recommend the optimal timing to take medication based on a variety of factors including a patient's metabolism (e.g., Ginger.io), as well as to optimize stroke patients' rehabilitation (e.g., Mindmaze), which is likely to lead to improved outcomes for patients including increasing life expectancy (Bughin et al. 2017). In some health care contexts, as noted earlier, AI may be used by doctors and other health care providers behind the scenes to help them make decisions about what to recommend. For example, IBM Watson for Oncology provides evidence-based cancer treatment recommendations based on a patient's medical information, drawing on a substantial amount of medical literature and experts at the Memorial Sloan Kettering Cancer Center (Somashekhar et al. 2018). The Noom app, using both human goal specialists and AI, motivates and provides personalized nutrition and training information and is the first of this type of program to be recognized as being effective at reducing the risk for diabetes by the U.S. Center for Disease Control and Prevention (Bonnington 2017). Going forward, greater personalization is likely to increase customer satisfaction and, as in the cases noted here, also enhance consumers' well-being.

#### 5.5.1.2 Enhanced Consumer Capabilities

While having more personalized service encounters can be beneficial and satisfying to customers, another key benefit that AI is providing is that it enables them to do things they could not do before by enhancing their capabilities (e.g., ability to analyze and gain insights from information). For example, beyond a simple search engine, Semantic Scholar examines a database of more than 40 million scientific papers in the areas of computer science and medicine. It can flag the most relevant and cited ones related to a request, looking for connections among studies with the hope that it will be able to identify key information and, in the future, a cure that

might have been otherwise missed (A better way to search through scientific papers 2017). AI also may be able to help improve our learning. For example, Muse, an AI-based app, offers parents activities especially tailored to their children that help build 50 different skills such as problem solving and growth mindset to develop traits such as emotional regulation and self-control that have been shown to predict positive life outcomes (Anderson 2018). Narrow AI has already shown an ability to outpace human capabilities in certain situations, especially in terms of recognizing patterns even in extreme data and identifying images (He et al. 2015).

#### 5.5.1.3 Increased Convenience and Time Savings

With AI incorporated into more areas of our life including, at some point, having it seamlessly integrated into our daily routine to take on our service tasks, it will enable consumers to gain efficiencies and save time. For example, virtual assistants are expected to be used to do much more than what they do today and be able to take care of a variety of service-related tasks on our behalf, offering an unprecedented level of convenience. AI assistants will "… ensure that routine purchases flow uninterrupted to households—just as water and electricity do now—and manage complexity of more-involved shopping decisions by learning consumers' criteria and optimizing whatever trade-offs people are willing to make (such as a higher price for more sustainability)" (Dawar 2018). In a variety of contexts, AI-based technology such as chatbots, not only increase personalization but also enable customers to get service when it is convenient for them similar to some SSTs. For example, universities using AdmitHub's chatbot can respond to students' questions 24 h a day and trigger a human response if it is less than 95% confident of the correct answer or when the concerns raised require more attention (e.g., financial issues, death of a family member, etc.) (Craig 2018). Customers value this convenience given recent research that found two-thirds of respondents indicated that they would be amenable to using AI-based services offered after hours (Wilson and Daugherty 2018). In the future, other AI-related technologies will also save us time. For example, autonomous cars are predicted to dramatically affect how we spend our time, both freeing up time not spent driving when we are in the car and freeing up time when the car can run errands itself (Williams 2018).

#### 5.5.1.4 Increased Well-Being Due to More Access for Unserved or Underserved Consumers

It could be argued that all three of the above outcomes could lead to increased well-being for consumers. However, AI's potential to enhance well-being goes beyond just more personalization, enhanced consumer capabilities, and time savings, to include more access to services, often for people who may typically be marginalized. Already "…virtual help agents have taken on surprisingly sensitive jobs in modern society: counseling Syrian refugees fleeing civil war, creating quiet spaces of contemplation for millions of Chinese living in densely populated cities, and helping

Australians access national disability benefits" (Molteni 2017). One setting where AI is likely to have profound effects is for the elderly. For example, AI, in the form of robots or virtual assistants, is poised to help address the shortage of caregivers in the context of eldercare. LifePod is a voice-controlled virtual caregiver that uses a combination of AI, including conversational voice assistance based on Alexa, and internet-enabled sensors to provide support to seniors (www.lifepod.com). Other AI-enabled offerings, including those developed as robot companions, are also being tested to help enhance eldercare (e.g., PARO therapeutic robot; www.parorobots.com). Research by Čaić et al. (2018) found that elderly consumers view socially assistive robots as having the potential to help safeguard their physical health in case of emergency and alert their caregivers if needed. These robots were also viewed as having the potential to maintain or improve psychosocial health by providing social contact, acting as a human companion, and facilitating the person's connection with the human social contacts in the person's network. Socially assistive robots may enable the elderly to remain independent longer when experiencing a decline in cognitive abilities by providing cognitive support (e.g., a reminder to take their medicine). Recent research suggests that anthropomorphized products, such as AI-enabled robots, can, at least partially, satisfy social needs, mitigating the response to social exclusion (Mourey et al. 2017).

In regards to mental health, there is evidence that AI-based virtual mental health services can be beneficial. For example, Woebot, a chatbot modeled on cognitive behavioral therapy, helps people learn about themselves through conversations, short video, word games, and mood graphing. Fitzpatrick et al. (2017) found that Woebot was able to significantly reduce depression and anxiety in college students over a 2-week period. It may be the case that Woebot, by not being human, is able to "lift the fear of judgement" (Molteni 2017). However, not much is known about the long-term effect of using Woebot. Deep Patient, developed using hospital data from 70,000 patients, showed an ability to predict disease as well as "anticipate the onset of psychiatric disorders like schizophrenia" (Knight 2017), which could help people to proactively get mental health assistance.

There are many opportunities for AI to help provide service to people who might otherwise have to go without. Examples include AI-based services to aid people with disabilities (e.g., Seeing AI, which is a Microsoft app that helps those who are visually impaired by audibly describing the environment, describing currency, reading out loud handwritten and short printed texts, among other capabilities; Microsoft Corporation 2018), robots that can interact with, learn to adapt to and support individuals with Alzheimer's (e.g., the PARO therapeutic robot noted earlier), and AI-based translation services that can facilitate interactions and reduce isolation arising from language issues. Another example is DoNotPay, a chatbot that started with a focus on contesting parking tickets in cities such as New York and London. At this point, it has saved people more than $9 million dollars, disputing some 375,000 parking tickets (Mannes 2017). The creator has recently launched 1000 new bots to help people complete transactional legal forms (e.g., landlord contract violations) in the U.S. and the U.K. (Mannes 2017). Overall, AI is demonstrating the ability to enhance consumers' physical, emotional and financial well-being.

### 5.5.2 Negative Consequences

Although there is significant discussion about the positive outcomes that might accrue to consumers due to AI, there are still many unknowns. With greater advances in and adoption of AI by service firms and as consumers' dependence on these AI-based services grows, consumers are more likely to experience negative outcomes. Below we highlight six possible negative consequences that might arise with greater adoption and usage of AI-based service encounters, which include the potential for more catastrophic service failures, negative service outcomes or service denial, perceived loss of control, perceived loss of privacy, diminished social skills, as well as the potential for greater consumer isolation.

#### 5.5.2.1 More Catastrophic Service Failures

With AI underpinning more service operations and expected to play a substantial role in coordinating our lives, the effects of technology breakdowns are likely to be more severe. Technology failures, although overall rare, still occur with the technology in place today (e.g., broken traditional SSTs, knowledge management systems that are not working, websites that crash). These failures sometimes occur in service contexts in which there are inadequate backup systems in place. As the capabilities of and our reliance on AI continues to grow, even global shutdowns are a possibility, whether due to true technology failure or through attempts to manipulate machine learning (Gangu 2018). If AI is driving decision-making in important contexts and it becomes non-operational, how will that be handled? Redundant systems can help, but when AI has moved beyond human capability, humans will not be able to step in to fix the issue likely leading to profound customer dissatisfaction.

#### 5.5.2.2 Negative Service Outcomes or Service Denial

Although AI has the potential to deliver highly personalized service, it also has the potential to make poor recommendations that lead to suboptimal service. For example, an AI system designed to help decide whether to hospitalize patients suffering from pneumonia 'learned' that those with asthma were less likely to die from it thus requiring them to need less hospitalization. However, this was due to the faster, more comprehensive care they actually receive because of their greater risk (Microsoft Corporation 2018). AI may also lead to service that is biased and discriminatory in ways that may be difficult to detect, leading to poor service and, in some cases, denial of service. In addition to the examples presented earlier, there is evidence that AI-based models being used to determine eligibility for parole, determine whether someone gets a bank loan or not, or is offered a job or not may have built in biases and discriminate against certain groups of consumers. At their

worst, AI models may have "... many poisonous assumptions (that) are camouflaged by math and go largely untested and unquestioned" (O'Neil 2016, p. 7). As noted by Byrne (2018), "If AI is going to be the interface between people and the critical services they need, how is it going to be fair and inclusive? How is it going to engage and support the marginalized people and the most vulnerable in our society?" Consistent with this sentiment, Nicolas Economou, CEO of H5, a legal technology firm, and a member of The Future Society, states, "Why should society trust that these secret algorithms are an accurate reflection of our person and that they don't prevent access to opportunity, to mortgages, to whatever credit we need? How do we know that credit practices are fair?" (Crosman 2018). We have already seen examples of AI's ability "to hardwire or amplify discrimination" and hence there is the potential for design choices to have unintended consequences including a lack of fairness across different populations (Anthony 2018). This can be exacerbated when there is a lack of diversity or representation involved in AI development. The quality of the data can also lead to incorrect outcomes due to hidden biases related to race, gender, or ethnicity, among others (Brynjolfsson and Mcafee 2017).

There seems to be significant potential for negative outcomes if there is a lack of transparency about how AI-based decisions are reached. This lack of explainability is problematic, especially in certain situations such as health care, financial services, emergency services, and defense that have significant well-being implications for consumers. It remains a major obstacle and there is indication that interpretable AI will take some time to develop. While AI developers can assess some models, there is little understanding of "how the most advanced algorithms do what they do," and it is difficult to design a system that can clearly communicate why it does what it does (Knight 2017). For example, an autonomous car has been developed that is able to drive based solely on an algorithm that taught itself to drive by watching humans drive (Knight 2017). However, if something unexpected were to happen, like a crash, it might be difficult to discern why. This type of deep learning is poised to transform industries. The likely impact on consumers and their experience is substantial. Efforts to ensure that AI systems involved in supporting, augmenting, or performing services make the appropriate recommendations/decisions and are free from bias are critical.

#### 5.5.2.3 Perceived Loss of Control

Given the power that AI may wield in coming years, a key issue is the effect it will have on consumers' perceived control. How much control and ability will customers have in settings where AI systems are making the decisions to provide service or determine the type of service customers should receive? Negative outcomes may result, especially in situations where AI is very competent but its goals are not aligned with ours ("Benefits and Risks of Artificial Intelligence" n.d.). An autonomous car getting somewhere "as fast as possible" without care for the physical and emotional state of its human occupant would no doubt be dissatisfying ("Benefits, and Risks of Artificial Intelligence," n.d.). This issue goes beyond just our

physical control but also control exerted by the relationships we will likely have with AI entities. AI systems that are designed to form relationships with us will likely be able to influence what we think and affect us in ways we might not realize (Yearsley 2017). If our AI virtual assistant structures our life (e.g., our allegiance shifts from "trusted brands to a trusted AI assistant"), what negative outcomes might occur given its power? (Dawar 2018). This lack of control and agency could lead to customer dissatisfaction and other negative consequences such as reduced well-being.

#### 5.5.2.4 Perceived Loss of Privacy

One key downside of the personalization enabled by AI is the lack of privacy that may result, due to an even greater trove of detailed information about us that is continually being gathered and analyzed. AI virtual assistants will have extensive knowledge about what we like, the tradeoffs we are willing to make, likely at a level we don't know ourselves (Dawar 2018). Robots in our physical spaces will have the ability to capture a significant amount of information about us including evaluating our mood and health (van Doorn et al. 2017).

AI is already leading to certain types of information being captured by companies that typically would not possess it. One example is Woebot mentioned earlier. The interaction between the technology and the person takes place through Facebook Messenger. Hence, it is Facebook, rather than the consumer or Woebot, that owns the conversations taking place (Molteni 2017). As is already happening today, data is being captured by companies in a variety of ways that they can use to tailor service encounters for us but they also may use it in ways we might not condone or view as ethical. The potential for negative outcomes in this area continues to grow as the skill and scale at which AI is operating increases. Importantly, consumers, companies, and governments are increasing their focus on ethical issues related to the implementation of AI in services and other contexts (Microsoft Corporation 2018; National Science and Technology Council 2016; Waters 2018).

#### 5.5.2.5 Diminished Social Skills

Concern has been raised about how our interaction with AI, either virtually or with robots, may affect our interaction style. This has been a point of discussion particularly in relation to children. In a widely discussed post, a San Francisco dad pondered whether his child ordering Alexa to do things without being polite might transfer to how she treats people (Walk 2016). Ultimately, we know very little about how children view digital assistants and how they will interpret the information that AI assistants provide (Hafner 2017). A study by M.I.T. Media Lab found that young children viewed AI devices such as Alexa, Google Home, Cozmo (a toy bulldozer robot), and a chatbot named Julie, as real people. Of the 27 children in the study, almost 80% believed "Alexa would always tell the truth" (Botsman 2017).

As children grow up having relationships with machines, what does it mean for how they will view relationships more broadly? As discussed by Sherry Turkle, the Founding Director of the M.I.T. Initiative on Technology and Self, could these machines alter "the ground rules of how people think about personhood" (Peachman 2017)? As virtual assistants become more seamlessly integrated into every aspect of our daily lives, to what extent might "irreplaceable aspects of human interaction ... atrophy in the process?" (Hafner 2017).

#### 5.5.2.6 Greater Isolation

While AI is projected to play a role in helping to provide social support in a variety of contexts, especially eldercare, it is still unclear the extent to which AI will be able to be a substitute for human interaction and companionship (Havens 2018). Although socially assistive robots have the potential to provide substantial positive benefits, it is also possible for there to be negative outcomes. For example, while Čaić et al.'s (2018) respondents identified benefits, they also highlighted possible negative outcomes that might result from relying on socially assistive robots. These include greater social isolation due to the AI replacing current human caregivers or having people in their social network interact with them less due to the AI being in place. Just as cellphones have changed the way we interact, the same will likely be true of AI. As AI assistants do more of our day-to-day tasks, there is the possibility that we will need to interact with other humans less, which could reduce social integration and increase feelings of loneliness.

## 5.6 Conclusions and Directions for Future Research

In this chapter, we take a modest view of AI by attempting to understand one important aspect of it—that is customer acceptance of narrow AI in the context of service encounters. We propose three types of AI enhanced service encounters—AI Supported, AI Augmented, and AI Performed (see Fig. 5.1), each of which demonstrates different roles for the customer, the frontline employee, and AI. While not purporting to be exhaustive, our conceptual framework illustrates and describes a set of theoretical antecedents of consumer acceptance of these AI-enhanced service encounters (see Fig. 5.2). We include previously studied antecedents such as those used to predict customer adoption of SSTs and we also explore AI-specific antecedents including privacy concerns, trust, and perceived creepiness. In addition, we discuss the positive and negative consequences for consumers of accepting AI and the tensions between them. For example, AI applications can result in greater personalization of offerings for customers while at the same time limiting customers' agency in self-defining their own options and increasing their privacy concerns. It is interesting to note that the technology paradoxes identified by Mick and Fournier (1998) 20 years ago still capture the ongoing discussions regarding the simultaneous

positive and negative effects that might occur as AI technology continues to advance. For example, they discuss how technology can facilitate freedom and independence with fewer restrictions, yet it can also lead to dependence or more restrictions. They also propose that technology can facilitate human togetherness as well as lead to human separation. These paradoxes and others seem equally applicable today in the age of AI as they were then.

There is much to be learned in this area in terms of what affects consumers' view of AI in the context of service encounters and the outcomes that they may experience. Figure 5.2 suggests a myriad of research questions that could be explored from both theoretical and practical perspectives. Every construct in the figure is worthy of deeper exploration and development in the context of AI. The linkages among the constructs—both direct effects and interactions—are also worthy of research. For example, on the antecedents side, what is the role of trust (of the provider and of the technology itself) in directly affecting acceptance of AI applications? And, how might the customer's role clarity and motivation interact with trust? If customers are highly motivated and totally understand their role, will trust be as important as when they are lacking in either or both? It would also be interesting to explore the tensions between the positive and negative consequences of AI. From a practical and ethical perspective, these are important questions. While there could be direct effects of customer acceptance on a positive outcome such as enhanced consumer capabilities, that increase in capabilities could also lead to more isolation if it keeps the consumer away from his or her more traditional interactions with frontline employees.

In addition to the specific relationships suggested by Fig. 5.2, there are many research questions of interest beyond what has been discussed, such as how does consumer choice as to whether or not to use AI influence how they perceive and evaluate it? What if they are forced to use it and have no choice at all? Will that affect how they react to it and the outcomes? What additional factors will play a significant role when AI begins to extend beyond narrow, task-specific applications and moves more into the realm of general AI? Will customers be willing to accept it then? Given the transformational effect that AI is predicted to have, this is a worthy area of focused attention.

AI is, without a doubt, a force that will continue to shape society, business practice, and our personal lives. How we approach it and how we integrate it, the ethical decisions we must face related to it, and its impact on our lives will be profound. Many daunting and challenging questions must be asked, including whether we ultimately want to create some form of super intelligence (Tegmark 2017). Or, how do we define work and meaningful human endeavor when AI is able to adequately perform most, if not all, of our current roles (Huang and Rust 2018)? Ultimately, it is not only about technology and its capabilities, but also about decisions and philosophical judgments we will make about AI's purpose and use.

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# Chapter 6
# Optimal Structure of Experiential Services: Review and Extensions

**Guillaume Roels**

**Abstract** In many consumer-intensive (B2C) services, delivering memorable customer experiences is often a source of competitive advantage. And yet, there exist few formal guidelines to design the structure of such experiences. In this chapter, we introduce a utility-based model of customer satisfaction when customers are subject to acclimation, satiation, and memory decay. We then review and extend principles for optimizing the structure of an experience to maximize customer satisfaction; specifically, we characterize the optimal sequence of activities, the optimal activity selection, and the optimal information policy about an uncertain outcome. We find that, in general, the optimal experience structure is non-monotone in service levels and makes use of breaks/intermissions to create contrasts and reset satiation levels. However, in many extreme cases, we show that a crescendo design is optimal. We then discuss the implications of our framework for quality management in services, especially as it relates to a potential gap between ex-ante expectation and ex-post satisfaction, and for monetizing customers' utilities derived while anticipating or recalling the event.

**Keywords** B2C services · Experiences · Behavioral operations management · Scheduling · Social psychology

## 6.1 Introduction

In competitive consumer-intensive (B2C) service industries (e.g., healthcare, leisure and hospitality, transportation), delivering memorable customer experiences is often a source of competitive advantage (McKinsey 2016). Experiences are indeed one of the key service differentiators once basic service outcomes are met for a given price

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_6

point (Berry et al. 2002). Experience drives customer satisfaction, which then drives customer loyalty (Braff and DeVine 2008), which in turn drives revenue growth and profitability (Heskett et al. 1994). In fact, Pine and Gilmore (1998, pp. 97–98) propose that "from now on, leading-edge companies ... will find that the next competitive battleground lies in staging experiences."

Because experiences are ubiquitous in B2C services and can be a source of competitive advantage, Ostrom et al. (2015) identify the topic of "enhancing the service experience" as one of the 12 research priorities for service research, and they classify it within the context of value creation. Zomerdijk and Voss (2010) identify six levers that can be pulled to enhance service experiences, namely (1) the orchestration of clues (or cues) that are emitted by products, services, and the environment, within and across service encounters (see, e.g., Berry et al. 2002, Haeckel et al. 2003), (2) the design of the sensory environment using, e.g., servicescape frameworks (Bitner 1992), (3) the engagement of front-line employees with customers, (4) the dramatic structure of the experience, (5) the management of the presence of fellow customers, and (6) the coordination between the front- and backstage processes, and more generally, of processes across customer interfaces, using, e.g., service experience blueprints (Patrício et al. 2008, 2011). This chapter focuses on the fourth lever, namely the design of the dramatic structure (i.e., the sequence, progression, and duration of activities) of an experience.

We take the perspective of a service provider who seeks to optimize the structure of a service encounter to maximize customer satisfaction. Throughout the encounter, the customer is exposed to various stimuli, which can be multi-dimensional and time-varying, and she derives (instantaneous) utility from them. Her satisfaction is a summary of these instantaneous utilities, assessed at the end of the process (Oliver 2015).

In practice, experiences are built up through a collection of touchpoints in multiple phases of a customer's decision process or purchase journey (Lemon and Verhoef 2016). We focus here on one such touchpoints, i.e., a particular encounter. Accordingly, we adopt customer satisfaction as our main performance objective, and not the more holistic metric of customer experience, which is affected by factors falling outside the encounter (e.g., search, after-sale purchase), across channels, or even outside the service provider's control (e.g., influence of others); see Verhoef et al. (2009).

Because the customer is the ultimate recipient of the experience (Pullman and Gross 2004), one needs to turn to behavioral science to understand how different types of experience structures affect customer satisfaction. Building on the findings from behavioral science, Chase and Dasu (2001) formulate five experience design principles: Finish strong; Get the bad experiences out of the way early; Segment the pleasure, combine the pain; Build commitment through choice; Give people rituals and stick to them. See also DeVine and Gilson (2010). Although these principles are very sensible, there has been little guidance—until recently—as to when and how they should apply.

To fill that gap, an emerging stream of research has offered novel design insights by formally modeling a customer's utility, with specific preferences or behavioral regularities, and optimizing the structure of the experiential process to maximize that utility.

The purpose of this chapter is to review that nascent literature and offer novel insights into the optimal design of the structure of service experiences by generalizing results by Das Gupta et al. (2015) and Ely et al. (2015), among others. Specifically, we propose a utility-based model of customer satisfaction when customers are subject to acclimation, satiation, and memory decay and we embed that utility model into a service design optimization model. We consider a single service encounter with fixed total duration, consisting of several activities, potentially preceded by an anticipation period and followed by a recall period. Throughout the experience, the customer is exposed to a sequence of activities, each associated with various service levels (or stimuli) from which the customer derives utility. Activities are homogenous in the sense that they are characterized by the same set of attributes, but they differ in terms of service levels on each of these attributes.

We study the following structure design decisions: How to sequence activities within the encounter? How to allocate duration to the activities? Which activities to select? How to reveal information about an uncertain state of nature to maximize suspense or surprise?

As proposed by Kahneman et al. (1997), customer satisfaction, or equivalently customers' remembered utility, may differ from their total utility derived from the service. In particular, we assume that customers are subject to memory decay (Ebbinghaus 1913); that is, when customers recall how much utility they derived from the experience, they put greater weight to the most recent events. In addition, we consider specific customer preferences, or behavioral regularities, which affect their instantaneous utilities. Specifically, we assume that customers are subject to acclimation (a.k.a., adaptation, habituation); that is, a customer's instantaneous utility from a particular activity's service level is assessed relative to a reference point, which adapts to states and reacts to changes (Hsee and Abelson 1991; Wathieu 1997). We also assume that customers are subject to satiation; in particular, a customer's instantaneous utility from a particular activity is a function of past consumption (Baucells and Sarin 2007). Finally, customers may exhibit decreasing marginal returns to gains (i.e., concave utilities) and loss aversion.

In practice, customer utilities may be subject to other behavioral preferences or regularities such as mental accounting or the endowment effect (see Thaler 2015 for an overview). We focus here on memory decay, acclimation, and satiation because their effect on satisfaction is intimately related to the structure of the experience (e.g., sequencing and duration of activities). In contrast, the effect of other behavioral factors (e.g., mental accounting) may be less related to the structure of the experience, but more to its framing (or marketing; e.g., communication, pricing), which falls outside the scope of this chapter. There are other behavioral factors that may be related to the structure of the experience (e.g., the primacy effect), but to the best of our knowledge, there has been no formal model characterizing the optimal experience design in the presence of these effects, and we leave it for future research to further explore those phenomena.

Throughout the analysis, we assume that customers are captive, i.e., are present from the beginning to the end of the encounter. In particular, we do not consider decisions that relate to customer engagement, such as the design of customer

narratives or work allocation policies (Roels 2014; Bellos and Kavadias 2017), and leave it to future research to incorporate those into our analytical framework. We also assume that the service is not customer-routed, that is, the sequencing, duration allocation, and activity selection decisions are under the provider's control. Examples of such non-customer-routed service experiences with homogenous activities and captive customers are live performances (e.g., music concerts, magic shows, fireworks), executive education programs, conferences, massages and spa treatments, fitness classes, museum tours, and dental procedures.

The chapter is structured as follows. In the next section, we introduce a utility-based model of customer satisfaction in the presence of acclimation, satiation, and memory decay, and we embed it within a generic optimization model of experience structure design. Sections 6.3–6.5 study three specific cases of structure design decisions: Considering a fixed set of activities with fixed duration and fixed service levels, Sect. 6.3 characterizes the optimal sequence of activities under various effects of acclimation, satiation, and memory decay. Considering fixed durations, Sect. 6.4 characterizes the optimal activity selection, subject to a budget constraint on their service levels. In Sect. 6.5, we consider a specific type of activities, namely messages that update customer beliefs about an uncertain outcome. We characterize the optimal sequence of messages, i.e., the optimal information policy, that maximizes customer satisfaction from their experienced suspense or surprise. Sections 6.6 and 6.7 expand the scope of the analysis beyond a single encounter to assess what happens before and after the experience. Specifically, Sect. 6.6 identifies a potential gap between a customer's ex-ante expectations about an experience and her ex-post satisfaction and discusses its implications for quality management; and Sect. 6.7 proposes a model of customer utility during anticipation and recall. We conclude in Sect. 6.8 with future research directions. All proofs appear in the Appendix.

## 6.2 Model

We consider a service encounter taking place over $T$ discrete time periods and consisting of $N$ activities. Each activity is characterized along $K$ orthogonal attributes, which can be physiological (e.g., noise, smell, sweetness), cognitive (e.g., level of mathematical sophistication), or emotional (e.g., fear, joy).

For any activity $i = 1, \ldots, N$, let $x_{k,i}$ be the service level on attribute $k = 1, \ldots, K$, and $\boldsymbol{x}_i = (x_{1,i}, \ldots, x_{K,i})$ be the corresponding vector of attributes. For simplicity, we assume that the service level remains constant during the duration of an activity. (Otherwise, an activity consisting of multiple phases with different service levels could be split into multiple activities with constant service levels.) In Sect. 6.5, we interpret $\boldsymbol{x}_i$ as a collection of messages.

Let $\underline{d}_i$ and $\bar{d}_i$ be respectively the lower and upper bounds on activity $i$'s duration. When $\underline{d}_i = \bar{d}_i$, the duration of the activity is fixed. When $\underline{d}_i = 0$, the service provider has the flexibility to spend zero time on activity $i$, i.e., to remove it from the encounter.

The service provider's decision consists of choosing which activity to schedule in any period. For any $t = 1, \ldots, T$, let $\pi_t$ be the activity index scheduled in period $t$; that is, $\pi_t = i$ if activity $i$ is scheduled in period $t$. Let $\boldsymbol{\pi} = (\pi_1, \ldots, \pi_T)$ be the service provider's decisions, constrained to belong to a feasible set $\Pi(\boldsymbol{x})$. In this model formulation, we keep the representation of $\Pi(\boldsymbol{x})$ abstract, but note that it can include many different types of constraints such as

- minimum activity durations, i.e., if Activity $i$ has been scheduled to start at time $t$, then no other activity can be scheduled in periods $t, \ldots, t + \underline{d}_i$, and Activity $i$ cannot be scheduled to start at an earlier or later time;
- precedence constraints, e.g., Activity $i$ must precede Activity $j$;
- budget constraint on the total set of activities being scheduled, e.g., when $K = 1$, $\sum_{t=1}^{T} x_{\pi_t} \leq B$ for some budget $B$;
- disjunctive constraints on activity selection, e.g., either Activity $i$ or Activity $j$ may be scheduled in the encounter, but not both of them.

With a slight abuse of notation, we denote by $\boldsymbol{x}_t = \boldsymbol{x}_{\pi_t}$ the service levels of the activity scheduled in period $t$, and by $\boldsymbol{x} = (\boldsymbol{x}_1, \ldots, \boldsymbol{x}_T)$ the corresponding vector. This generic framework can encompass such design decisions as activity sequencing, duration allocation, or activity selection.

The utility the customer derives from an activity scheduled in period $t$ depends on three variables, namely,

1. the activity's service level on each attribute $k$, denoted as $x_{k,t}$, with $\boldsymbol{x}_t = (x_{1,t}, \ldots, x_{K,t})$,
2. a reference level on attribute $k$ at the beginning of period $t$, denoted as $r_{k,t}$, with $\boldsymbol{r}_t = (r_{1,t}, \ldots, r_{K,t})$, and
3. a satiation level on attribute $k$ at the beginning of period $t$, denoted as $s_{k,t}$, with $\boldsymbol{s}_t = (s_{1,t}, \ldots, s_{K,t})$.

We denote by $u_k(x, r, s)$ the customer's instantaneous utility associated with service level $x$ on attribute $k$ with a reference level $r$ and a satiation level $s$. Following Baucells and Sarin (2010), we assume that

$$u_k(x, r, s) = v_k(x - r + s) - v_k(s), \tag{6.1}$$

in which $v_k(x)$ denotes the customer's instantaneous utility associated with service level $x$ on attribute $k$ with an initial reference level of zero and an initial satiation level of zero. We assume throughout that $v_k(x)$ is increasing and that $v_k(0) = 0$. For certain results (e.g., Propositions 3, 5, 6, and 7), we will make additional restrictions on $v_k(x)$, such as concavity or loss aversion.[1]

[1]Prospect theory posits that is concave for all $x \geq 0$, convex for all $x < 0$, and exhibits loss aversion in the sense that $-v_k(-x) \geq v_k(x) \geq 0$ for all $x > 0$; see, e.g., Baucells and Sarin (2010) and Kőszegi and Rabin (2006).

Hence, the utility a customer derives from a service level $x$ is assessed relative to a reference point $r$, and the higher that reference point, the smaller the utility. For instance, a customer entering a store that has an ambient temperature of 70 °F will enjoy more the ambient warmth if the outside temperature is low. In addition, the utility from current consumption is a function of past consumption, i.e., of the satiation level $s$; specifically if $v_k(x)$ is concave, the higher past consumption, the lower the utility from current consumption. For instance, a customer eating steak will enjoy more utility if she is hungry than if she just had a filling appetizer.

Attributes are orthogonal in the sense that reference and satiation levels on attribute $k$ are a function of past service levels on that particular attribute $k$, but independent of the past service levels on the other attributes $l \neq k$. Similar to Baucells and Sarin (2010), we consider the following state transitions:

$$r_{k,t+1} = \alpha\, x_{k,t} + (1-\alpha)\, r_{k,t} \tag{6.2}$$

$$s_{k,t+1} = \gamma\, (x_{k,t} - r_{k,t} + s_{k,t}), \tag{6.3}$$

in which $\alpha \in [0,1]$ is the rate of acclimation (a.k.a. adaptation, habituation) and $\gamma \in [0,1]$ is the rate of decay in the satiation level. More general models could consider attribute- or activity-specific rates.

Following Kőszegi and Rabin (2006), Bleichrodt et al. (2009), and Baucells and Sarin (2010), we assume that the instantaneous utility associated with a multi-attribute service level $\boldsymbol{x}_t$, reference level $\boldsymbol{r}_t$, and satiation level $\boldsymbol{s}_t$, denoted as $u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t)$, is additively separable, i.e.,

$$u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t) = \sum\nolimits_{k=1}^{K} u_k(x_{k,t}, r_{k,t}, s_{k,t}). \tag{6.4}$$

Although the customer derives a *total* utility $U(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum\nolimits_{t=1}^{T} u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t)$ from the experience (Edgeworth 1881), the customer's *remembered* utility, which drives future purchase decisions, usually differs from the total utility (Kahneman et al. 1997). Let $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1)$ be the customer's remembered utility, or *satisfaction*, derived from an encounter featuring service levels $\boldsymbol{x}$, when the customer's reference level and satiation level at the beginning of the encounter are equal to $\boldsymbol{r}_1$ and $\boldsymbol{s}_1$. A customer who is subject to memory decay (Ebbinghaus 1913), will remember more recent events than past events. With exponential memory decay, this leads to

$$S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{t=1}^{T} \delta^{T-t}\, u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t), \tag{6.5}$$

in which $\delta$ is the rate of memory decay (Das Gupta et al. 2015). More generally, serial effects such as primacy and recency could be incorporated (Karmarkar and

Karmarkar 2014), e.g., $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{t=1}^{T} w_t\, u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t)$, where $w_t$ is the weight associated with position $t$.[2,3]

Alternatively, Frederickson and Kahneman (1993) suggested that customers only remember the peak and the end of an experience, i.e., that $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \delta \max_{t=1,\ldots,T} u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t) + (1 - \delta)\, u(\boldsymbol{x}_T, \boldsymbol{r}_T, \boldsymbol{s}_T)$. Building upon the peak-end rule, Dixon and Verma (2013) empirically find that customers' remembered utility from a concert season of a performance art center is a function of the peak, end, spread (i.e., timing of the peak), and trend. Dixon and Thompson (2016) use this objective to optimize season bundles. However, the peak-end rule is deceptive for design since it would imply that all sequences of activities with the same end would lead to identical satisfactions.

In this chapter, we consider a model with acclimation, satiation, and memory decay. Accordingly, the service provider seeks to optimize the sequence of activities, allocate duration, and/or select activities to maximize customer satisfaction,

$$\max_{\boldsymbol{\pi} \in \Pi(\boldsymbol{x})} S((\boldsymbol{x}_{\pi_1}, \ldots, \boldsymbol{x}_{\pi_T}), \boldsymbol{r}_1, \boldsymbol{s}_1)$$

when the customer is subject to memory decay, i.e., (6.5), when utilities are additively separable across attributes, i.e., (6.4), and when the customer is subject to acclimation, i.e., (6.1) and (6.2), and satiation, i.e., (6.1) and (6.3).

We next characterize the optimal design in three particular cases, namely (1) the optimal sequencing of activities for a fixed set of activities with fixed duration; (2) the optimal selection of activities when there is a budget constraint on the aggregate service levels; and (3) considering activities as messages, the optimal information policy to maximize recollection of suspense or surprise.

## 6.3 Activity Sequencing

In this section, we consider a fixed set of activities with fixed durations (i.e., $\underline{d}_i = \bar{d}_i = d_i \geq 1$) such that $\sum_{i=1}^{N} d_i = T$ and we characterize the optimal sequence of activities to maximize customer satisfaction. In order to derive first-order structural results, we assume no precedence constraints, i.e., all permutations are possible.

In general, the optimal sequence of activities can be quite complex in the presence of the three behavioral factors of acclimation, satiation, and memory decay, and a complete characterization is beyond the scope of this chapter. Instead, we next consider several extreme cases, and we find that sequencing activities in increasing

[2]Even without explicitly modeling primacy effects, we find that a U-shape sequence may be optimal under Model (6.5). See Proposition 5.

[3]Baucells and Bellezza (2017) consider an even more general model with a discount factor that is period-specific and dependent on the magnitude of the utility experienced in that period.

**Table 6.1** Summary of results on optimal sequences

| Proposition | Memory decay | Acclimation | Satiation | Utility | Optimal design |
|---|---|---|---|---|---|
| 1 | | No ($\alpha = 0$) | No ($\gamma = 0$) | | Crescendo |
| 2 | | No ($\alpha = 0$) | Full ($\gamma = 1$) | | Crescendo |
| 3 | No ($\delta = 1$) | Full ($\alpha = 1$) | No ($\gamma = 0$) | Subadditive, loss aversion | Crescendo |
| 4 | No ($\delta = 1$) | | Full ($\gamma = 1$) | | Crescendo |
| 5 | | | | Linear | U-shaped |

order of service levels, i.e., in crescendo, is often optimal. Considering single-attribute service levels (i.e., $K = 1$), the first two propositions study the role of memory decay with full or no decay in satiation (i.e., $\gamma = 0$ or $\gamma = 1$), and the next two propositions study the role of acclimation with full or no decay in satiation. We then consider multi-attribute service levels when utilities are linear (i.e., $v_k(x) = w_k x$ for all $k$). Table 6.1 offers a summary of our results on optimal sequences.

Considering single-attribute service levels, we first characterize the case with only memory decay, no acclimation, and no satiation, generalizing the result obtained by Das Gupta et al. (2015) to the case of nonlinear utility functions. Because memory decay puts greater weight on the last activities, it is optimal to schedule the activities with the highest service levels near the end of the encounter.

**Proposition 1:** Suppose that $K = 1$ and that $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$. When there is no acclimation nor satiation ($\alpha = \gamma = 0$), it is optimal to sequence activities in increasing order of service level.

The next proposition complements Proposition 1 by considering the case with no decay in satiation. Similar to the case with no satiation, a crescendo is optimal when satiation never decays.

**Proposition 2:** Suppose that $K = 1$, that $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$. When customers experience no decay in satiation ($\gamma = 1$) and never acclimate ($\alpha = 0$), it is optimal to sequence activities in increasing order of service level.

However, for intermediate levels of decay in satiation ($0 < \gamma < 1$), the optimal sequence when there is no acclimation may not necessarily be a crescendo, as illustrated in Fig. 6.1. In order to yield a high utility in the last periods (which are heavily weighted due to memory decay), it is important to set the satiation level prior to the last period $s_T$ at a low value. Because of decay in satiation, the satiation level $s_T$ depends more on the most recent service levels than on the earlier ones. Accordingly, it may be optimal to drop the service levels in the middle of the encounter to reset the satiation level to a low value and maximize the utility derived from the subsequent activities. Effectively, one should insert a break or intermission to reduce satiation and fully enjoy the end of the encounter.

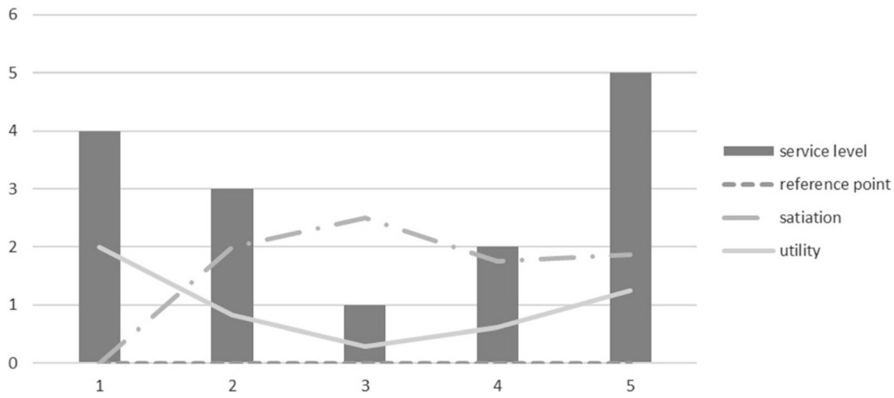



**Fig. 6.1** Optimal sequence with memory decay, but no acclimation. (Note: $\delta = 0.2$, $\alpha = 0$, $\gamma = 0.5$, $v(x) = \sqrt{x}$ if $x \geq 0$ and $-\sqrt{-x}$ if $x < 0$, $T = 5$, $r_1 = 0$, $s_1 = 0$, $\boldsymbol{x} = (1, 2, 3, 4, 5)$. Optimal sequence identified through exhaustive search)

We next investigate the role of acclimation without memory decay (i.e., when $\delta = 1$). Das Gupta et al. (2015) show that with linear utilities, crescendos are optimal. We next generalize their result to the case with nonlinear utilities.

We first consider the case of no satiation ($\gamma = 0$) and assume full acclimation ($\alpha = 1$). We require the utility function to be such that for all $x > 0$, $v(x + y) \leq v(x) + v(y)$, which is a weak form of subadditivity (and satisfied when $v(x)$ is concave), and that $-v(-x) \geq v(x) \geq 0$ for all $x > 0$, which implies loss aversion. Under those conditions, an increasing sequence $x_1 < x_2 < x_3$ always generates greater satisfaction than a U-shaped sequence (e.g., $x_2 > x_1 < x_3$), because the disutility obtained from the initial drop in service levels will not be compensated by the utility obtained from the final increase in service levels due to loss aversion.

**Proposition 3:** Suppose that $K = 1$, that $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$, that, for all $x > 0$, $v(x + y) \leq v(x) + v(y)$, and that $-v(-x) \geq v(x) \geq 0$ for all $x > 0$. When customers fully acclimate ($\alpha = 1$), but experience neither memory decay ($\delta = 1$) nor satiation ($\gamma = 0$), it is optimal to sequence activities in increasing order of service level.

The next proposition complements Proposition 3 by considering the other extreme of satiation, i.e., when there is no decay in satiation level ($\gamma = 1$). Unlike Proposition 3, no condition is required on the shape of the utility function.

**Proposition 4:** Suppose that $K = 1$ and that $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$. When customers experience no decay in satiation ($\gamma = 1$) and no memory decay ($\delta = 1$), it is optimal to sequence activities in increasing order of service level.

However, for intermediate levels of decay in satiation ($0 < \gamma < 1$), the optimal sequence when there is no memory decay may not necessarily be a crescendo, as illustrated in Fig. 6.2. Decreasing the service level of the activities in the middle of the encounter indeed resets both the reference point and the satiation level to low

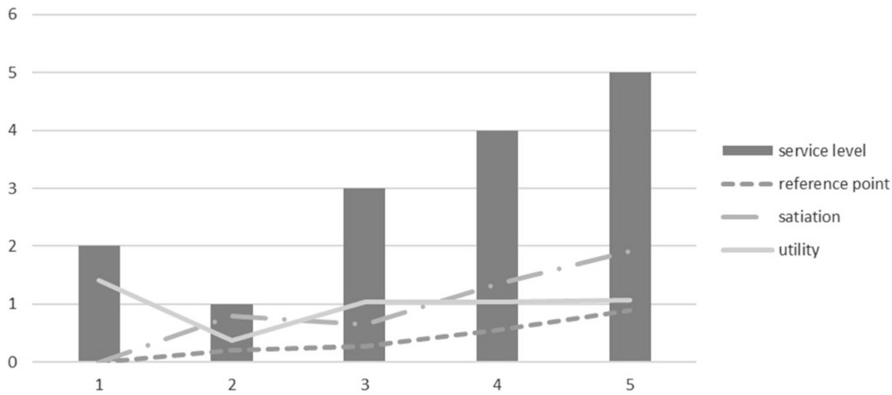



**Fig. 6.2** Optimal sequence with acclimation, but no memory decay. (Note: $\delta = 1$, $\alpha = 0.1$, $\gamma = 0.4$, $v(x) = \sqrt{x}$ if $x \geq 0$ and $-\sqrt{-x}$ if $x < 0$, $T = 5$, $r_1 = 0$, $s_1 = 0$, $\boldsymbol{x} = (1, 2, 3, 4, 5)$. Optimal sequence identified through exhaustive search)

values, thereby increasing the utility from the subsequent activities. Although this initial drop in service level may potentially result in negative utility due to acclimation (especially in the presence of loss aversion), such disutility can be mitigated if the satiation levels are high already. Here the role of the break or intermission is not only to reduce satiation, but also to create contrast.

Overall, we have shown that when satiation exhibits either full or no decay, memory decay and acclimation individually lead to crescendos. A common recommendation for experience designers is indeed to "finish strong;" for instance, the tour of Guinness Storehouse ends with a highly-valued complimentary drink in a sky bar (Zomerdijk and Voss 2010).

However, as shown in Das Gupta et al. (2015), even with no satiation, combining memory decay and acclimation could lead to U-shaped optimal designs, as is illustrated in Fig. 6.3. The intuition is as follows: Together, memory decay and acclimation favor a steep gradient in service levels near the end of the encounter. To achieve a sharp increase in service levels at the end of the encounter it may be optimal to move some of the activities that are associated with a high service level at the beginning of the encounter. Although this results in negative utility when the customer experiences a drop in service levels, this carries little weight in the customer's overall assessment of the encounter given that this disutility happens at the beginning of the encounter and tends to be forgotten. U-shape sequences are in fact ubiquitous in practice, such as in music concert's sequence of songs (Baucells et al. 2016) or in arc-like structures of exposition (Zomerdijk and Voss 2010).

We next generalize the characterization obtained by Das Gupta et al. (2015) to multi-attribute service levels for linear utilities. With linear utilities, satiation has no impact. In this case, the optimal sequence is in general U-shaped in the activities' weighted average service levels, and the last two activities are sequenced in increasing order of weighted average service level.

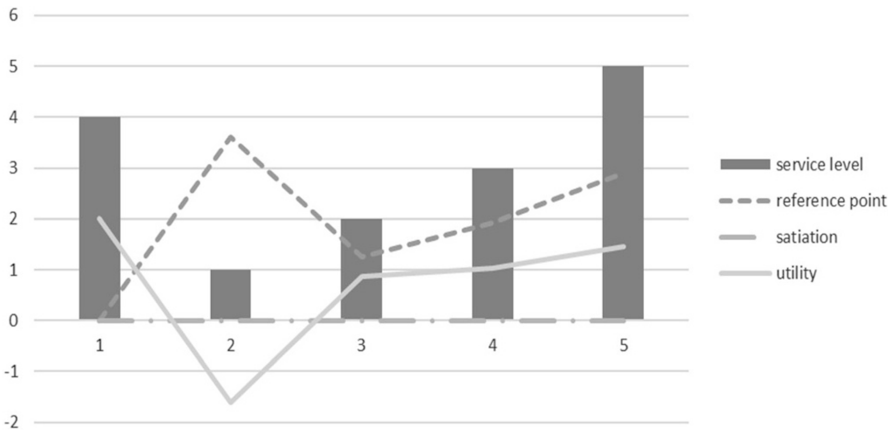



**Fig. 6.3** Optimal sequence with acclimation and memory decay, but no satiation. (Note: $\delta = .5$, $\alpha = 0.9$, $\gamma = 0$, $v(x) = \sqrt{x}$ if $x \geq 0$ and $-\sqrt{-x}$ if $x < 0$, $T = 5$, $r_1 = 0$, $s_1 = 0$, $\boldsymbol{x} = (1, 2, 3, 4, 5)$. Optimal sequence identified through exhaustive search)

**Proposition 5:** Suppose that $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$ and that $v_k(x) = w_k\, x$ for all $k$. Then, it is optimal to sequence activities in a U-shaped fashion in terms of weighted average attributes $\sum_{k=1}^{K} w_k\, x_{k,i}$. In particular, if Activity $i$ precedes Activity $j$ in the optimal sequence and

- If Activity $j$ is not the last activity, then $\sum_{k=1}^{K} w_k\, x_{k,i} \geq \sum_{k=1}^{K} w_k\, x_{k,j}$ if and only if the starting time of Activity $i$ is less than $t \leq T + 1 - \$\$\frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}+\delta^{-d_i-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}+(1-\alpha)^{-d_i-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$.
- If Activities $i$ and $j$ are the last two activities, then $\sum_{k=1}^{K} w_k\, x_{k,i} \leq \sum_{k=1}^{K} w_k\, x_{k,j}$.

  In particular, for short encounters, i.e., when $T \leq \frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}+\delta^{-d_i-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}+(1-\alpha)^{-d_i-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$ $-1$ for all possible durations $(d_i, d_j)$, it is optimal to sequence activities in increasing order of their weighted service level $\sum_{k=1}^{K} w_k\, x_{k,i}$. This condition can easily be shown to hold true when there is no memory decay ($\delta = 1$) or no acclimation ($\alpha = 0$), consistent with Propositions 1 and 3.

With nonlinear utilities, satiation matters, and the optimal design is in general more complex than a crescendo or a U-shape. For instance, Fig. 6.4 shows that even in the absence of memory decay ($\delta = 1$) and acclimation ($\alpha = 0$), the optimal design could consist of multiple local minima aimed at resetting the satiation level to a low value and increasing the utility from the subsequent activities. Because of satiation, it may thus be optimal to insert breaks in a performance to maximize the utility from the next segments.

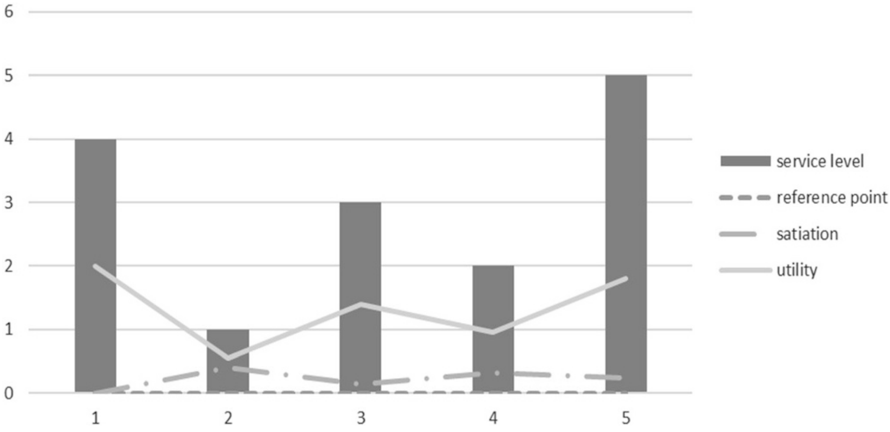



**Fig. 6.4** Optimal sequence with satiation, but no acclimation and no memory decay. (Note: $\delta = 1$, $\alpha = 0$, $\gamma = 0.1$, $v(x) = \sqrt{x}$ if $x \geq 0$ and $-2\sqrt{-x}$ if $x < 0$, $T = 5$, $r_1 = 0$, $s_1 = 0$, $\boldsymbol{x} = (1, 2, 3, 4, 5)$. Optimal sequence identified through exhaustive search)

## 6.4 Activity Selection

In contrast to the previous section, which considered a given set of activities to be sequenced, we now consider how to select activities under a budget constraint on their service levels. Specifically we assume that $K = 1$ and set the feasible set such that $\Pi(\boldsymbol{x}) = \left\{ \boldsymbol{x} \middle| \sum_{t=1}^{T} x_t \leq B \right\}$.[4] (In addition, we can restrict service levels to be nonnegative at the expense of more cumbersome notation.) Economists and decision scientists (e.g., Samuelson 1937, Koopmans 1960) have studied how to optimize an individual's future consumption plan to maximize her expected utility subject to a budget constraint. In contrast to that literature, which optimizes a customer's ex-ante discounted utility, we optimize here a customer's ex-post satisfaction; that is, time discounting operates backward here (due to memory decay) as opposed to forward.

We first characterize the optimal activity selection when the customer is subject to both acclimation and memory decay, but not to satiation. As established in Proposition 5 and illustrated in Fig. 6.3, when the service provider controls only the sequence of activities, the optimal design may end up being U-shaped so as to induce a steep gradient in service levels near the end of the encounter, but at the expense of negative utilities in the early periods of the encounter. In contrast, when the provider is free to select which activities to schedule, this trade-off is no longer at

[4] A more general model with multi-attribute activities could consider that the intensity of each attribute moves proportionally to the budget allocated to the activity, i.e., consider attributes as rays specific to each activity.

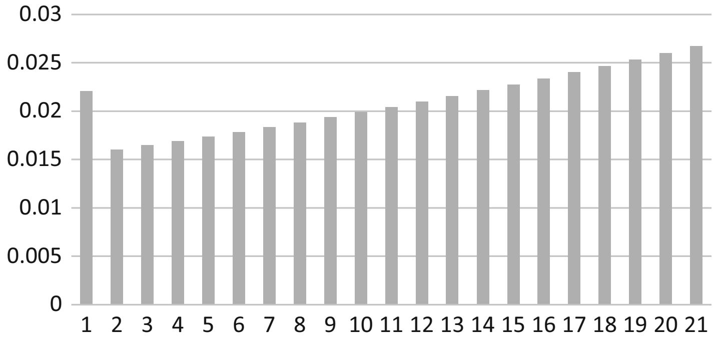



**Fig. 6.5** Optimal activity selection with satiation and memory decay, but no acclimation. (Note: $\delta = 0.97$, $\alpha = 0$, $\gamma = 0.3$, $v(x) = x^{1/4}$, $T = 20$, $\lambda = 1$, $s_1 = 0$)

work and it is optimal to allocate the budget so that the net service level, $x_t^* - r_t$, is increasing over time. With power utility functions, i.e., when $v(x) = x^\beta$, this results in a crescendo sequence.

**Proposition 6:** Suppose that $K = 1$ and $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$. When customers experience no satiation ($\gamma = 0, s_1 = 0$), when $v'(x) > 0$, $v(0) = 0$, and $v''(x) < 0$ for all $x$, and when the service provider is free to set any service level subject to a budget constraint, i.e., when $\Pi(\boldsymbol{x}) = \left\{\boldsymbol{x} \middle| \sum_{t=1}^{T} x_t \leq B\right\}$, it is optimal to set the service levels such that $x_{T-t}^* = r_{T-t} + \left(v'\right)^{-1}\left(\frac{\lambda(1+t\alpha)}{\delta^t}\right)$ for all $t = 0, \ldots, T-1$, in which $\lambda > 0$ is such that $\sum_{t=1}^{T} x_t^* = B$. Moreover, $x_t^* - r_t$ is increasing in $t$. If in addition $v(x) = x^\beta$ for some $0 < \beta < 1$ when $x \geq 0$, $x_{T-t}^* \geq x_{T-t-1}^*$ for all $t = 0, \ldots, T-2$.

We next consider the case with satiation and memory decay, but no acclimation. Baucells and Sarin (2007) showed that, when $\delta = 1$, the optimal service levels were constant in period $t = 2, \ldots, T-1$, and observed that an individual's optimal consumption plan (with forward discounting) was in general decreasing over time, with possible upticks in the first and last periods. Considering customer satisfaction (with backward discounting) as the objective, we complement their result by showing that the optimal service levels are in general increasing over time, with possible upticks in the first and last periods; see Fig. 6.5 for an illustration.

**Proposition 7:** Suppose that $K = 1$ and $\underline{d}_i = \bar{d}_i = d_i \geq 1$ for all $i$. When customers experience no acclimation ($\alpha = 0$), when $v'(x) > 0$ and $v''(x) < (\gamma^2/\delta)v''(\gamma x) < 0$ for all $x$, and when the service provider is free to set any service level subject to a budget constraint, i.e., when $\Pi(\boldsymbol{x}) = \left\{\boldsymbol{x} \middle| \sum_{t=1}^{T} x_t \leq B\right\}$, it is optimal to set the service levels such that $v'\left(x_T^* + s_T\right) = (1-\gamma)\lambda$ and $v'\left(x_{T-t}^* + s_{T-t}\right) - \$\$(\gamma/\delta)\, v'\left(\gamma\left(x_{T-t}^* + s_{T-t}\right)\right) = (1-\gamma)\lambda/\delta^t$ for all $t = 1, \ldots, T-1$, in which $\lambda > 0$ is such that $\sum_{t=1}^{T} x_t^* = B$.

Moreover, $x_t^* + s_t$ is decreasing in $t$. If in addition $v(x) = x^\beta$ for some $\ln\delta/\ln\gamma < \beta < 1$ when $x \geq 0$, then $x_{T-t}^* \geq x_{T-t-1}^*$ for all $t = 0, \ldots, T-3$; on the other hand, it may be that $x_2^* < x_1^*$.

Comparing Propositions 6 and 7 shows that the optimal net service level $x_t^* + s_t - r_t$ is increasing in $t$ with acclimation and no satiation and decreasing in $t$ with satiation and no acclimation. We conjecture that, with both acclimation and satiation, the optimal net service level will evolve in a non-monotone fashion and we leave it for future research to characterize the optimal activity selection in this more general case.

## 6.5 Suspense and Surprise

In entertainment, games, and sports, experiences are often characterized by an uncertain outcome (e.g., the name of the murderer in a mystery novel, or the winner of a tennis game), where uncertainty is gradually resolved as the experience unfolds. In such settings, customers may derive utility from suspense and/or surprise as they update their beliefs about the outcome, based on various information signals they capture during the experience.

We consider here a particular case of the model proposed by Ely et al. (2015) and extend their results to accommodate memory decay. Specifically, we consider an experience characterized by an uncertain event (e.g., the event that a book's main character would defeat a villain, or that one favorite's tennis player wins a game) that may be true or false. We adopt a broader conceptualization of the notion of service levels introduced in Sect. 6.2 to encompass an information policy, i.e., a set of signals to send to the customer so that she can update her beliefs about the likelihood of the event under consideration.[5]

If the customer updates her beliefs in a Bayesian fashion, the sequence of her beliefs form a martingale in the sense that the best estimate for next period's belief is the customer's current belief. Ely et al. (2015, Lemma 1) show that, for any belief martingale, there exists an information policy that induces such belief martingale. Hence, from a modeling standpoint, one need not model the details of the service provider's information policy. Indeed, one may frame the service provider's decision as choosing the customer's posterior distribution of beliefs, provided that the martingale property is satisfied, i.e., that the expected value of that posterior distribution is equal to the customer's current belief.

[5] Although a book writer has complete control over the unfolding of the story, a sports event or game manager may not fully control it; yet, the rules of the sport or game may be altered to induce more or less variance in outcomes, as is currently under consideration for the game of tennis (*The Economist* 2017).

Within the framework introduced in Sect. 6.2, we model the customer's prior belief as her reference point $r_t$ and the service provider's decision as the choice of a posterior belief distribution that respects the martingale property. Let $\tilde{x}_t$ be the (random) posterior belief. The service provider thus needs to choose a distribution $F(\tilde{x}_t) \in \Phi(r_t)$, where $\Phi(r_t)$ is the set of probability distributions $F(\tilde{x}_t)$ such that $\mathbb{E}_F[\tilde{x}_t] = \int_0^1 \tilde{x}_t dF(\tilde{x}_t) = r_t$ and $\int_0^1 dF(\tilde{x}_t) = 1$, in which $\mathbb{E}_F[.]$ denotes the expectation operator. Hence, the provider's decision in period $t$, given state $r_t$, is a distribution of beliefs $F(\tilde{x}_t) \in \Phi(r_t)$, i.e., the service provider randomizes over posterior beliefs.

Because the customer's posterior belief in period $t$ will become her prior belief in period $t + 1$, the state transition (6.2) simplifies to $r_{t+1} = x_t$, as if $\alpha = 1$. It is thus as if the service provider were randomizing between service levels (the posterior distribution) and the customer were fully adapting to the realized service level; there is no concept of satiation in this model (i.e., $\gamma = 0$).

In addition to being subject to memory decay, the customer derives (instantaneous) utility from *suspense*, i.e., from the variance in next period's beliefs relative to her current period's beliefs, and/or from *surprise*, i.e., from any jump in belief from the previous period to the current one. As in Sect. 6.2, we assume memory decay; thus customer satisfaction evaluated at the end of the encounter puts greater weight on the most recent instantaneous utilities. Formally, the satisfaction of a customer who values *suspense* is equal to $S(\boldsymbol{x}, r_1) = \sum_{t=1}^{T} \delta^{T-t} \sqrt{\mathbb{E}_F\left[\left(\tilde{x}_t - r_t\right)^2\right]}$, and that of a customer who values *surprise* is equal to $S(\boldsymbol{x}, r_1) = \sum_{t=1}^{T} \delta^{T-t}\, \mathbb{E}_F[|\tilde{x}_t - r_t|]$. (With a slight abuse of notation, we use here the same notation to refer to both suspense and surprise, in reference to the concept of customer satisfaction introduced in Sect. 6.2, but note that they correspond to two different objectives.) See Ely et al. (2015) for more general forms of utility, multidimensional outcome uncertainty, and trade-offs between suspense and surprise. In particular, the model can be expanded to incorporate preferences for specific outcomes (e.g., preference that one's favorite hero would survive at the end) in addition to suspense and surprise (Ely et al. 2015).

Given that the service provider adapts the signals to the customer's beliefs, the service provider's choice of signals (or equivalently, of posterior probability distributions of beliefs) can be cast as a dynamic optimization problem. Let $\delta^{T-t} W_t(r_t)$ be the expected satisfaction generated from the instantaneous utilities derived from time $t$ to the end of the encounter $T$, if the customer's current belief is equal to $r_t$. This customer's "satisfaction-to-go" function can be defined recursively as follows:

$$W_{T+1}(r_{T+1}) = 0 \quad \text{for all} \quad r_{T+1}, \tag{6.6}$$

and if the customer values suspense:

$$W_t(r_t) = \max_{F \in \Phi(r_t)} \sqrt{\mathbb{E}_F\left[\left(\tilde{x}_t - r_t\right)^2\right]} \\ +\delta^{-1}\,\mathbb{E}_F\left[W_{t+1}\left(\tilde{x}_t\right)\right], \forall t < T, \tag{6.7}$$

and if she values surprise:

$$W_t(r_t) = \max_{F \in \Phi(r_t)} \mathbb{E}_F[|\tilde{x}_t - r_t|] \\ +\delta^{-1}\,\mathbb{E}_F\left[W_{t+1}\left(\tilde{x}_t\right)\right], \forall t < T. \tag{6.8}$$

In each period the service provider's optimization problem consists in choosing a distribution subject to moment constraints, namely that $\int_0^1 \tilde{x}_t dF\left(\tilde{x}_t\right) = r_t$ and $\int_0^1 dF\left(\tilde{x}_t\right) = 1$. It turns out that, with two moments, there exists a 2-point distribution that attains the optimum (Smith 1995). Hence, it is enough to restrict the optimization to searching over 2-point distributions that satisfy the moment constraints. In particular, $F$ is a 2-point distribution that belongs to $\Phi(r_t)$ if there exists two numbers $\bar{x}_t$ and $\underline{x}_t$ such that $1 \geq \bar{x}_t \geq r_t \geq \underline{x}_t \geq 0$, such that $F(x) = 0$ for all $x < \underline{x}_t$, $F(x) = \frac{\bar{x}_t - r_t}{\bar{x}_t - \underline{x}_t}$ for all $\underline{x}_t \leq x < \bar{x}_t$, and $F(x) = 1$ for all $x \geq \bar{x}_t$. With these observations, we next extend the results by Ely et al. (2015) to the case with memory decay. We first consider the case of suspense.

**Proposition 8:** When the customer values suspense and is subject to memory decay i.e., $S(\boldsymbol{x}, r_1) = \sum_{t=1}^{T} \delta^{T-t} \sqrt{\mathbb{E}_F\left[\left(\tilde{x}_t - r_t\right)^2\right]}$ with $\delta < 1$, it is optimal for the service provider solving (6.6) and (6.7) to send signals such that if the customer's belief in period $t < T$ is equal to $r_t$, then her posterior belief at the end of period $t$ is equal to $\frac{1}{2} + \sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1-\delta^{-2}}{1-\delta^{-2(T-t+1)}} r_t(1 - r_t)}$ with probability $½ + \frac{\left(r_t - \frac{1}{2}\right)}{2\sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1-\delta^{-2}}{1-\delta^{-2(T-t+1)}} r_t(1-r_t)}}$ and to $\frac{1}{2} - \sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1-\delta^{-2}}{1-\delta^{-2(T-t+1)}} r_t(1 - r_t)}$ with probability $½ - \frac{\left(r_t - \frac{1}{2}\right)}{2\sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1-\delta^{-2}}{1-\delta^{-2(T-t+1)}} r_t(1-r_t)}}$. In period $T$, full revelation is optimal, i.e., the customer's posterior belief at the end of period $T$ is equal to 1 with probability $r_T$ and 0 with probability $1 - r_T$.

Similar to Ely et al. (2015), we find that, in order to maximize suspense under memory decay, it is optimal to fully reveal the outcome in period $T$, and only in period $T$. Figure 6.6 illustrates a typical belief sample path. In the figure, the markers

**Fig. 6.6** Posterior belief sample path with suspense and memory decay. (Note: $T = 10$, $\delta = 0.95$, $r_1 = 0.5$)

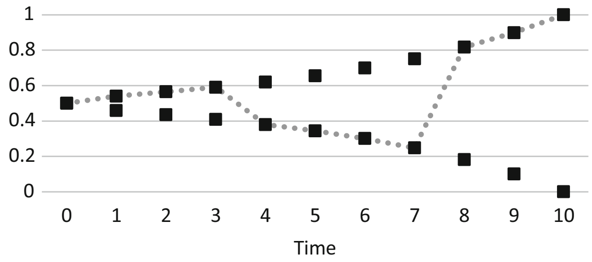
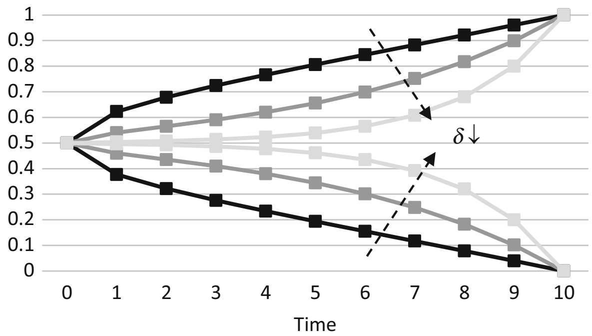



**Fig. 6.7** Posterior belief feasible sets with suspense as a function of memory decay. (Note: $T = 10$, $\delta = 0.95$ (*black curves*), $\delta = 0.8$ (*dark grey curves*), $\delta = 0.6$ (*light grey curves*), $r_1 = 0.5$)




indicate the set of possible posterior beliefs $\{r_t\}$ whereas the dotted line represents a sample path. Belief updates consist of either confirmation beliefs, which reinforce the current belief (i.e., if the current belief is greater than 0.5, the next period's belief is higher than the current belief), or plot twists, which make beliefs switch from one path to the other. The sample path depicted in Fig. 6.6 depicts two plot twists, in period 4 and in period 8. As the experience unfolds, given the dependence of the probabilities on $r_t$, confirmation beliefs are more frequent and plot twists less frequent.

In contrast to Ely et al. (2015), who show that, in the absence of memory decay (i.e., when $\delta = 1$), the variance in beliefs $\sqrt{\mathbb{E}_F\left[\left(\tilde{x}_t - r_t\right)^2\right]}$ remains constant across periods under the optimal policy; Proposition 8 shows that with memory decay, a crescendo in variance in beliefs is optimal. That is, the variance in beliefs should be increasing over time since a customer who is subject to memory decay will put higher value to suspense that happens at the end of the encounter. Figure 6.7 shows that, as the intensity of memory decay increases (i.e., as $\delta$ decreases), the feasible set of the beliefs becomes more narrow and evolves more sharply near the end of the encounter. (Here, we connected the markers depicting the feasible sets, but a sample path may alternate between the boundaries of the feasible set, similar to Fig. 6.6.) As a result, memory decay induces more stable beliefs throughout most of the experience, but greater uncertainty about the final outcome near the end of the experience.

We next consider the combined effect of surprise and memory decay, generalizing the result obtained by Ely et al. (2015). As Ely et al. (2015), we only consider three periods and leave it for future research to analytically characterize the optimal solution when $T > 3$.

**Proposition 9:** When the customer values surprise and is subject to memory decay, i.e., $S(\boldsymbol{x}, r_1) = \sum_{t=1}^{T} \delta^{T-t}\, \mathbb{E}_F[|\tilde{x}_t - r_t|]$, if $T = 3$ and $r_1 \in [\delta(1 + \delta)/4, 1 - \delta(1 + \delta)/4]$, it is optimal for the service provider solving (6.6) and (6.8) to send signals such that the customer's posterior belief at the end of period $t$ is equal to $r_t + \delta^{T-t}/4$ with probability ½ and to $r_t - \delta^{T-t}/4$ with probability ½. In period $T$, full revelation is optimal, i.e., the customer's posterior belief at the end of period $T$ is equal to 1 with probability $r_T$ and 0 with probability $1 - r_T$.

Figure 6.8 illustrates Proposition 9 when $r_1 = 1/2$. The markers represent the feasible set of posterior beliefs and the lines denote possible belief trajectories. As in the case with suspense, it is optimal to fully reveal the outcome in the last period; however, unlike the case with suspense, it may be optimal to do so before the last period if $r_1 \notin [\delta(1 + \delta)/4, 1 - \delta(1 + \delta)/4]$. (This latter case is not depicted in the figure since it is assumed that $r_1 = 1/2$.) In case of early resolution of uncertainty, the customer's utility in the last periods is equal to zero, given that no surprise is generated once the time the state of the event is revealed. Although it may seem counterintuitive to fully reveal the state before the end of the encounter, the possibility of such sample paths enriches the overall environment and makes the other sample paths more surprising. For instance, if every mystery novel always followed the same story template, e.g., always revealed the name of the murderer in the last chapter, there would be little room for surprise as the reader would then give no credibility to any early suspicion on identifying the murderer.

In addition, sample paths of beliefs under surprise are much spikier than sample paths under suspense. While beliefs under suspense are mostly confirming, with occasional twist plots that become less frequent as time goes by, beliefs under surprise go up and down by small increments with equal probability. Until the uncertainty is fully resolved, beliefs evolve as a random walk in which the magnitude of the steps in either direction increases over time, but the probability of updating beliefs upwards or downwards remains constant at 50%.

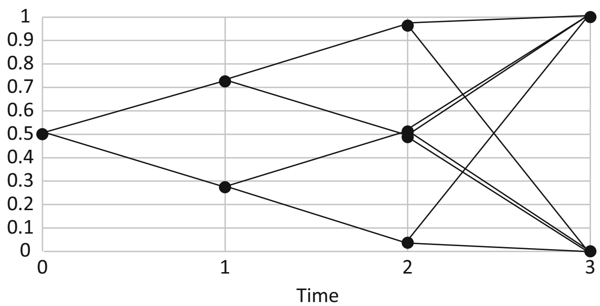



**Fig. 6.8** Posterior belief feasible sets with surprise and memory decay. (Note: $T = 3$, $\delta = 0.95$, $r_1 = 0.5$)

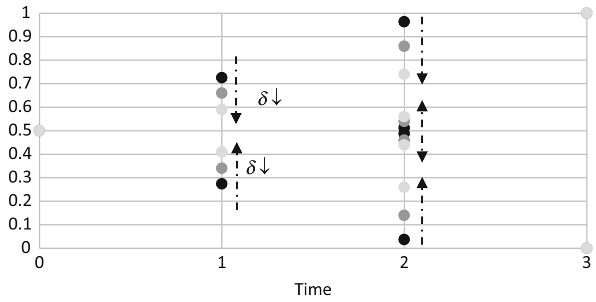



**Fig. 6.9** Posterior belief feasible sets under surprise as a function of memory decay. (Note: $T = 3$, $\delta = 0.95$, (*black dots*), $\delta = 0.8$ (*dark grey dots*), $\delta = 0.6$ (*light grey dots*), $r_1 = 0.5$)

Because of memory decay, a crescendo in surprise is optimal. Specifically, as illustrated in Fig. 6.9, as memory decay increases (i.e., as $\delta$ decreases), the funnel of belief sample paths become narrower up to the next-to-last-period, creating more room for a high (and memorable) surprise in the last period. In particular, full revelation of the outcome before the last period becomes less likely with greater memory decay. Hence, similar to its effect on suspense, memory decay tends to prolong a high degree of uncertainty about the final outcome when the customer values surprise. Moreover, the greater the memory decay, the smaller the belief updates from one period to the next. However, in contrast to its effect on suspense, memory decay does not affect the likelihood of revising upwards or downwards one's beliefs, which remains constant at 50% until uncertainty is fully resolved.

## 6.6 Gap Model: Satisfaction and Expectation

Our discussion has so far consisted in maximizing customer's *satisfaction*, evaluated ex-post, i.e., $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{\tau=1}^{T} \delta^{T-\tau}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$, when the customer is subject to memory decay with decay rate $\delta$. In contrast, a customer discounting time at rate $\theta$, consistent with the economics literature (Samuelson 1937; Koopmans 1960), would value ex-ante the total utility she expects to receive from the experience as $E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{\tau=1}^{T} \theta^{\tau-1}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$. (The term "expectation" refers to the ex-ante nature of the assessment, and not to the stochastic nature of the experience, unlike Sect. 6.5.)

There may be a discrepancy between the customer's ex-ante expectations from the service and the overall ex-post satisfaction because consumption is discounted forward in the former and backward in the latter. As a result, customers' perceived service quality, which generally stems from comparing what they feel the service firm should offer with their perceptions of the performance of the firm (Parasuraman et al. 1988; Oliver 2015), i.e., from $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1)$, could be affected by that discrepancy.

In particular, a customer with reservation utility $\bar{U}$ may choose to join a service priced at $p$ if she expects to obtain a positive surplus from the transaction, i.e., if

$E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - p \geq \bar{U}$; see, e.g., Aflaki and Popescu (2013) and Bellos and Kavadias (2017). The service provider, in turn, sets its price to capture the entire customer surplus, i.e., to $p = E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - \bar{U}$. Accordingly, when the customer evaluates her relative satisfaction from the service at the end of the encounter (e.g., to consider patronizing the service in the future), she will compare her overall satisfaction from the service to the price she paid, i.e.,

$$S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - p = S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) + \bar{U} = \sum_{t=1}^{T} \left(\delta^{T-t} - \theta^{t-1}\right) u(\boldsymbol{x}_t, \boldsymbol{r}_t, \boldsymbol{s}_t) + \bar{U}. \tag{6.9}$$

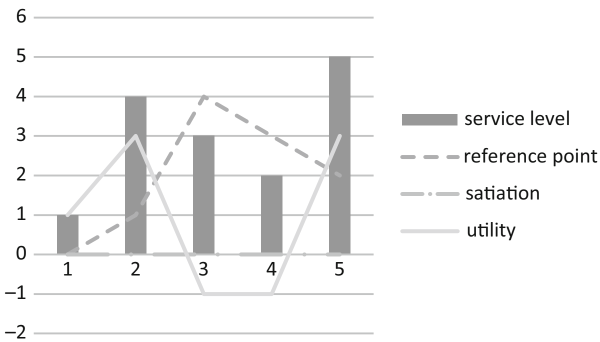
In (6.9), each instantaneous utility is weighted by $(\delta^{T-t} - \theta^{t-1})$. Although this difference in discount factors is increasing over time (similar to memory decay), the optimal design may change. For instance, with linear utility functions, the sequence that maximizes customer satisfaction is U-shaped (Proposition 6), but the one that maximizes (6.9), i.e., the gap between customer satisfaction and expectations, may have an interior local maximum, as shown in Fig. 6.10.

In particular, when the customer's perceived quality is a function of the gap between her ex-post satisfaction and her ex-ante satisfaction, it may be optimal for the service provider, if her objective is to maximize the customer's perceived quality, to set low expectations (provided of course, that the customer is captive) so as to increase that gap. In Fig. 6.10, swapping the order between the first activity ($x = 1$) and the second activity ($x = 4$) would result in higher expectations (because of the immediacy of the consumption of the high service level $x = 4$), which would then negatively affect the gap between satisfaction and expectations.

With uncertainty in the delivery of the service levels and misaligned communication, the gap could be even larger. To illustrate this, suppose that service levels $\boldsymbol{X}$ are random (e.g., due to lack of process conformance and heterogeneity in customer's inputs) with realization $\boldsymbol{x}$. Suppose also that the customer, from what she heard about the service or past experience, expects to receive (random) service levels $\boldsymbol{Y}$. With these constructs, the total gap between the satisfaction the customer derives from the service and her expectation of utility prior to the experience, is equal to

$$S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - \mathbb{E}[E(\boldsymbol{Y}, \boldsymbol{r}_1, \boldsymbol{s}_1)].$$

**Fig. 6.10** Sequence that maximizes gap between satisfaction and expectation. (Note: $\theta = 0.2$, $\delta = 0.8$, $\alpha = 1$, $v(x) = x$, $\boldsymbol{x} = (1, 2, 3, 4, 5)$)



Similar to Karmarkar and Roels (2015), this gap can be broken down into the following subcomponents:

- A process conformance gap, $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) - \mathbb{E}[S(\boldsymbol{X}, \boldsymbol{r}_1, \boldsymbol{s}_1)]$, which measures the expected gap between a customer's actual satisfaction and the expected satisfaction the process is supposed to deliver; the discrepancy here lies in the randomness in service levels;
- A customer's quality perception gap, $\mathbb{E}[S(\boldsymbol{X}, \boldsymbol{r}_1, \boldsymbol{s}_1)] - \mathbb{E}[E(\boldsymbol{X}, \boldsymbol{r}_1, \boldsymbol{s}_1)]$, which measures the gap between a customer's expected ex-post satisfaction (given the random service levels) and her ex-ante expectations; the discrepancy here lies in the way the customer aggregates the sum of individual utilities to set her expectations (forward discounting) and to assess her satisfaction (backward discounting);
- A communication gap, $\mathbb{E}[E(\boldsymbol{X}, \boldsymbol{r}_1, \boldsymbol{s}_1)] - \mathbb{E}[E(\boldsymbol{Y}, \boldsymbol{r}_1, \boldsymbol{s}_1)]$, which measures the gap between a customer's expectations from the service, if she knew ahead of time the sequence of activities (and the variations in service levels) $\boldsymbol{X}$ relative to her expectations based on what she anticipates to receive $\boldsymbol{Y}$.

In principle, nothing precludes these gaps to be negative, in which case they would be quality-enhancing. For instance, in case the customer values suspense or surprise, it may be optimal to introduce some degree of variability in the service levels $\boldsymbol{X}$, as discussed in Sect. 6.5.

Assuming positive gaps, this gap decomposition highlights three possible levers to improve quality:

- To improve process conformance by reducing the variability in inputs (customer- or server-related) and in process execution;
- To align customers' ex-ante and ex-post assessment methods of how much utility they derive; for instance, memory decay from a vacation can be reduced by keeping a log of the most memorable events;
- To improve the relevance of marketing campaigns to create more realistic expectations about the service delivery.

Naturally, additional gaps could exist if the service provider misunderstands the value customers derive from service levels (i.e., their utility function $v(x)$), their extent of memory decay ($\delta$), acclimation ($\alpha$), and satiation ($\gamma$), or the way they discount future consumption ($\theta$).

## 6.7 Anticipation and Recall

We next extend the scope of our analysis to include periods of anticipation (before the encounter) and recall (after the encounter). Customers indeed derive utility from anticipating an event (Jevons 1905), and that utility can be positive (savoring) or negative (dread), depending on the nature of the event (Lowenstein 1987). Similarly, customers may derive utility from recalling the event (Baucells and Bellezza 2017).

Similar to Baucells and Bellezza (2017), we distinguish three phases: anticipation, event, and recall. Let $t_a$ be the time at which anticipation starts, $t_b$ be the time at which service begins, $t_e$ be the time at which service ends, i.e., $t_e = t_b + T$, and $t_r$ be the time at which recall ends.

During the anticipation phase, the customer looks forward to the forthcoming events, but discounts them as they are far in the future (Jevons 1905). To formalize this growing anticipation, let $\beta$ be the anticipation discount factor, which may not necessarily be equal to the discount rate used to discount future consumption (Lowenstein 1987). At time $t_a$, the anticipated utility from the experience is thus equal to $E(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{\tau=t_b}^{t_e} \beta^{\tau - t_b}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$. We denote by $u_A(E, t)$ the utility derived in period $t$, $t_a \leq t < t_b$, from anticipating a total utility $E$. Because it depends on the total discounted utility, the anticipated utility is thus a function of both the intensity and the duration of the event (Jevons 1905).

The anticipated utility could include time discounting, e.g., $u_A(E, t) = k_A\, \beta^{t_b - t}\, E = k_A \sum_{\tau=t_b}^{t_e} \beta^{\tau - t}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$ (Lowenstein 1987). It could also include reference effects (Baucells and Bellezza 2017). For instance, let us denote by $\rho_{A,\ t}$ be the reference point at time $t$ on the total anticipated utility and by $\alpha_A$ the acclimation rate in the anticipation phase. With acclimation and time discounting, the utility derived at time $t$ from anticipating an experience generating a utility of $E$ can be defined as $u_A\left(E, \rho_{A,t}, t\right) = \beta^{t_b - t} v_A\left(\left(E - \rho_{A,t}\right)\right)$, where $\rho_{A,\ t+1} = \alpha_A\, E + (1 - \alpha_A)\, \rho_{A,\ t}$ for all $t$, $t_a \leq t < t_b$, and $\rho_{A, t_a} = 0$, $v_A^{'}(x) \geq 0$, and $v_A(0) = 0$.

Similarly, utilities during the recall phase depend on the total satisfaction $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{\tau=t_b}^{t_e} \delta^{t_e - \tau}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$, which discounts utilities backward due to memory decay. We denote $u_R(S, t)$ as the utility derived in period $t$, $t_e < t \leq t_r$, from recalling a total utility $S$. The recalled utility could include time discounting, e.g., $u_R(S, t) = k_R\, \delta^{t - t_e}\, S = k_R \sum_{\tau=t_b}^{t_e} \delta^{t - \tau}\, u(\boldsymbol{x}_\tau, \boldsymbol{r}_\tau, \boldsymbol{s}_\tau)$, but it could also include reference effects (Baucells and Bellezza 2017). For instance, let us denote $\rho_{R,\ t}$ as the reference point at time $t$ on the total recalled utility and by $\alpha_R$ the acclimation rate in the recall phase. With acclimation and memory decay, the utility at time $t$ from recalling an experience generating satisfaction $S$ can be defined as $u_R\left(S, \rho_{R,t}, t\right) = \delta^{t - t_e} v_R\left(\left(S - \rho_{R,t}\right)\right)$, where $\rho_{R,\ t+1} = \alpha_R\, S + (1 - \alpha_R)\, \rho_{R,\ t}$ for all $t$, $t_e < t \leq t_r$, and $\rho_{R, t_e} = 0$, $v_R^{'}(x) \geq 0$, and $v_R(0) = 0$.

In principle, the reference points during anticipation and recall, i.e., $\rho_{A,\ t}$ and $\rho_{R,\ t}$, may be different constructs from the reference points during the experience itself, i.e., $r_t$, given that the objects of utility during anticipation and recall, namely the total expectation $E$ and the total satisfaction $S$, are different from the objects of utility during the experience, namely the service levels $\boldsymbol{x}_t$. Alternatively, one may assume that the reference point evolves continuously throughout the different phases of anticipation, experience, and recall (Baucells and Bellezza 2017).

Figure 6.11 depicts the evolution of a customer's instantaneous utility during the phases of anticipation, event, and recall, when the event consists of a constant service level of 1, starting from period 5 to period 10, in the presence of acclimation

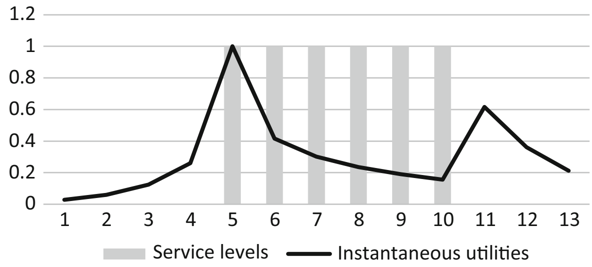



**Fig. 6.11** Instantaneous utilities under anticipation, experience, and recall. (Note: $t_a = 1$, $t_b = 5$, $t_e = 10$, $t_r = 13$, $\alpha = \alpha_A = \alpha_R = 0.3$, $\beta = 0.4$, $\gamma = 0.4$, $\delta = 0.7$, $\rho_{A,\,1} = \rho_{R,\,11} = r_5 = 0$, $s_5 = 0$, $v(x) = v_A(x) = v_R(x) = \sqrt{x}$ if $x \geq 0$ and $-2\sqrt{-x}$ if $x < 0$)

during all phases and satiation during the event. During the event, the customer experiences a burst of utility at the beginning ($t = 5$) because the service level ($x = 1$) is higher than her reference point ($r_5 = 0$) and because her level of satiation is low ($s_5 = 0$). As the event progresses, the customer's instantaneous utility declines as she acclimates to the high service level and starts satiating.

In the anticipation phase ($1 \leq t \leq 4$), because the anticipation time discount factor ($\beta = 0.4$) is relatively small, utilities increase as time gets closer to the actual start of the event. However, should the customer discount time less (i.e., higher $\beta$) or acclimate more quickly (i.e., higher $\alpha_R$), utilities could be decreasing as the time-distance to the event would matter less and the customer would acclimate more quickly to the prospect of the event. With a more intricate model of time discounting, Baucells and Bellezza (2017) show that utilities during the anticipation phase could even be U-shaped.

At the beginning of the recall phase ($t = 11$), the customer experiences another burst of utility from the comparison between the total satisfaction and the recall reference point (set to zero). As the distance from the event increases ($11 < t \leq 13$), this utility gradually declines over time as memory fades away and the reference point adjusts to the satisfaction level. Unlike the anticipation phase, the effects of time discounting and acclimation are aligned during the recall phase and we expect recall utilities to be always trending towards zero.

Although it is well documented that customers derive utilities from anticipation and recall, it is unclear how service firms could capitalize on them since the experience either has not started or has been completed. Lowenstein (1987) observed that the total discounted utility, assessed in period $t_a$,

$$\sum_{t=t_a}^{t_b} \theta^{t-t_a}\, u_A\left(E, \rho_{A,t}, t\right) + \sum_{t=t_b}^{t_b+T} \theta^{t-t_a}\, u(\boldsymbol{x}, r_{t_b}, s_{t_b}) + \sum_{t=t_b+T}^{t_r} \theta^{t-t_a}\, u_R\left(S, \rho_{R,t}, t\right),$$

in which $\theta$ is the regular rate at which customers discount future consumptions, may be unimodal in $t_b$. In that case, it may be optimal to delay or advance the consumption of the experience. In fact, Baucells and Bellezza (2017) demonstrate that in some cases, it may be optimal to advance the event to the point that there is no anticipation, i.e., a surprise. Hence, if a firm has control on when to start an experience, after they engaged with a customer, they may want to optimize the starting time of the experience to maximize the customer's total discounted utility.

Similarly, in the example used to build Fig. 6.11, we observed that the total discounted utility is unimodal in $t_a$; that is, when $\theta = .9$, setting $t_a = 2$ instead of $t_a = 1$ (but keeping $t_b$, $t_e$, and $t_r$ unchanged) improves the total discounted utility from 1.87 to 2.05. Hence, even for experiences that have been scheduled on particular dates (fixed $t_b$), service firms could potentially optimize the time they reach out to customers so that they can start anticipating the event. For instance, marathon organizers typically send participants emails in anticipation to the marathon. In particular, and consistent with our discussion of the gap model in Sect. 6.6, a customer may be willing to pay the highest price for an experience when her total discounted utility (including anticipation and recall) is the highest. By strategically timing its engagement with its customers, a service firm may then be able to charge a higher price for its service (and the anticipation and recall thereof).

## 6.8 Conclusions

In this chapter, we reviewed and extended existing results to design the structure of experiential services when customers are subject to acclimation, satiation, and memory decay. In particular, we considered how to sequence a given set of activities, how to select activities subject to a budget constraint on the activities' service levels, and how to disclose information about an uncertain event to maximize a customer's ex-post satisfaction, i.e., a customer's remembered utility from the service. We also discussed the design implications on service quality, specifically on the potential gap between a customer's ex-ante expectations and ex-post satisfaction, and on customer's anticipation and recall from the experience.

One may think that, in order to deliver outstanding experiences, one needs to achieve outstanding service in every activity of an encounter. Although this would certainly be a costly strategy, as argued by the design firm IDEO (Zomerdijk and Voss 2010), we showed here that this could even be counterproductive: There is indeed value creating contrast (because of acclimation) and interruptions (because of satiation). Rather than striving to excel on every activity, for a given structure of experience (e.g., sequence, activity selection and duration, information policy), one may create higher customer satisfaction by keeping the activities' service levels fixed, but changing the overall structure of the experience.

We demonstrated that crescendo designs often turn out to be optimal. Hence, despite their simplicity, they should not be underappreciated. A common design recommendation is indeed to "finish strong." While this is a robust recommendation,

we identified the mechanisms under which this design is optimal. Specifically, when the satiation level either never or fully decays (Propositions 1–4) or when the customer's utility is linear (Proposition 5), and the customer is subject to either only memory decay or only acclimation, the optimal sequence of activities is a crescendo. Similarly, when activities need to be selected, the optimal design tends to a crescendo in service levels, with the exception perhaps of the first activity (Propositions 6 and 7), although the *net* service levels (i.e., relative to the reference point and satiation level) may not be monotone. Finally, when customers value suspense or surprise, memory decay leads to an information policy that increases the level of suspense or surprise over time (Propositions 8 and 9).

In general, however, the optimal design may be more complex, potentially U-shaped (Proposition 5), but also potentially with many "breaks" (Fig. 6.4). Inserting breaks resets satiation levels, creates more contrasts, and may make the subsequent activities more enjoyable. With memory decay, the potential disutility arising from an early break may be quickly forgotten, but the boost in utility in the last activities arising from the resetting satiation levels and creating contrast will tend to be the most memorable.

On potential caveat of this research is that since customers are all different, they may respond differently to particular structures of experience. However, even if different customers derive different levels of satisfaction from crescendo or U-shaped designs, they may still prefer these structures over alternative designs. Moreover, these designs tend to be relatively robust (Das Gupta et al. 2015); that is, even if there is a loss of optimality, it tends to be small. Finally, we note that the development of information technology potentially enables real-time customization of experiences (Rust and Oliver 2000); thus, if customer preferences are properly elicited, there is an opportunity to customize the experience to maximize every individual customer's satisfaction.

The stream of research on the design of structure of experiences is emerging and the opportunities for analytical extensions are numerous. Some of the potential opportunities are:

Incorporate other behavioral factors in the customer utility model such as preferences for specific sequences, timing of peak, trend, etc. (Karmarkar and Karmarkar 2014; Dixon and Thompson 2016) and hyperbolic discounting (Plambeck and Wang 2013).

Incorporate other "stock" variables (besides satiation), such as moods and trust (Dasu and Chase 2010), which can be affected by reputation (Gebbia 2016).

Capture the notion of customer engagement or control (Dasu and Chase 2010), perhaps due to customer participation (a.k.a., the IKEA effect, see Norton et al. 2012), which would require incorporating a model of joint production (Roels 2014; Rahmani et al. 2017; Bellos and Kavadias 2017).

Relax the assumption that customers are captive and test the robustness of the crescendo design in that case.

Leverage group dynamics, such as social comparisons (Roels and Su 2013) and learning (Acemoglu et al. 2011), in case the experience involves a group of customers.

Enlarge the scope of the analysis beyond the single encounter to encompass the anticipation and recall phases and what drives customer retention across encounters (Aflaki and Popescu 2013), and more generally, what drives customer experience throughout their journey (Verhoef et al. 2009).

In addition to these analytical extensions, further empirical evidence is needed to estimate the parameters of the model (acclimation rate, satiation decay rate, memory decay rate) and validate the model predictions about customers' preferences for specific designs. This analytical work built upon findings from psychology and behavioral science, but it may now be time to go back to the lab or the field, validate (or not) the model predictions, inform future analytical developments, and improve the accuracy of their predictions and the relevance of their prescriptions. In the spirit of design thinking, it would be valuable to actively engage customers in the design process, leverage technological advances to come up with novel service designs, fertilize multi-disciplinary research, and derive design principles through iterative hypothesis testing and prototyping; see Patrício et al. (2018) for an outline of a research agenda along those directions.

Finally, from a practical standpoint, service providers operating customer-routed services (e.g. theme parks, online experiences) should investigate how to guide customers to choose a sequence of activities that maximize their ex-post satisfaction (e.g., through recommendations), which may differ from the sequence they may choose ex-ante. In addition, service providers should investigate how to monetize customer utilities derived in the anticipation and recall periods, perhaps by targeting customers at the time their ex-ante expectations about their total utility is the highest. In an era where experiences can be engineered by computers,[6] we believe the time is indeed ripe for deriving more formal guidelines for designing the structure of experiences.

**Acknowledgments** I would like to thank Uday S. Karmarkar, Lia Patrício, and two anonymous referees for sharing their insights and suggestions for improving the quality of the chapter.

## Appendix

**Lemma 1:** For any $p, q \geq 1$ and $x \in [0, 1]$, $1 - x^{-p} - x^{-q} + x^{-p-q} \geq 0$.

*Proof:* The derivative of the function $1 - x^{-p} - x^{-q} + x^{-p-q}$ with respect to $p$ equals $x^{-p} \ln x\, (1 - x^{-q}) \geq 0$, and similarly for the derivative with respect to $q$. Hence, for any $p, q \geq 1$, $1 - x^{-p} - x^{-q} + x^{-p-q} \geq 1 - x^{-1} - x^{-1} + x^{-2} = (1 - x^{-1})^2 \geq 0$. ∎

[6]For instance, the trailer of the movie Morgan was compiled by IBM's Watson; see https://www.ibm.com/blogs/think/2016/08/cognitive-movie-trailer/

**Lemma 2:** For any $p, q \geq 1$ and $x \in [0, 1]$, $1 - x^{-p} - x^{-q} + x^{-p-q}$ is decreasing in $x$.

*Proof:* The derivative of the function $1 - x^{-p} - x^{-q} + x^{-p-q}$ with respect to $x$ equals $(p+q)\, x^{-p-q-1}\left(\frac{p}{p+q} x^q + \frac{q}{p+q} x^p - 1\right)$, and it is negative given that $x^q \leq 1$ and $x^p \leq 1$. ∎

*Proof of Proposition 1:* The proof uses an interchange argument. Throughout the proof, since $K = 1$, we omit the subscript $k$. Because $\alpha = \gamma = 0$, $S(\boldsymbol{x}, r_1, s_1) = \sum_{\tau=1}^{T} \delta^{T-\tau}\, v(x_\tau - r_1) - v(s_1)$. Suppose that, in the optimal sequence, Activity $i$ starts in time period $t$ and immediately precedes Activity $j$. In that case, because $x_\tau = x_i$ whenever $\pi_\tau = i$, we obtain

$$
\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) = {} & \sum_{\tau=1}^{t-1} \delta^{T-\tau}\, v(x_\tau - r_1) + \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau}\, v(x_i - r_1) \\
& + \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau}\, v\left(x_j - r_1\right) \\
& + \sum_{\tau=t+d_i+d_j}^{T} \delta^{T-\tau}\, v(x_\tau - r_1) - v(s_1).
\end{aligned}
$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that $S(\boldsymbol{x}, r_1, s_1) - S\left(\tilde{\boldsymbol{x}}, r_1, s_1\right) \geq 0$, i.e.,

$$
\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) & - S\left(\tilde{\boldsymbol{x}}, r_1, s_1\right) \\
& = \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau}\, v(x_i - r_1) + \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau}\, v\left(x_j - r_1\right) \\
& - \sum_{\tau=t}^{t+d_j-1} \delta^{T-\tau}\, v\left(x_j - r_1\right) - \sum_{\tau=t+d_j}^{t+d_i+d_j-1} \delta^{T-\tau}\, v(x_i - r_1) \\
& = v(x_i - r_1) \left( \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau} - \sum_{\tau=t+d_j}^{t+d_i+d_j-1} \delta^{T-\tau} \right) \\
& + v\left(x_j - r_1\right) \left( \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau} - \sum_{\tau=t}^{t+d_j-1} \delta^{T-\tau} \right) \\
& = (v(x_i - r_1) \\
& - v\left(x_j - r_1\right))\delta^{T-t} \frac{1 - \delta^{-d_i} - \delta^{-d_j} + \delta^{-d_i-d_j}}{1 - \delta^{-1}} \geq 0,
\end{aligned}
$$

which implies, by Lemma 1, that $v(x_i - r_1) \leq v(x_j - r_1)$. Because $v(x)$ is increasing, this implies that $x_i \leq x_j$. ∎

*Proof of Proposition 2:* The proof uses an interchange argument. Throughout the proof, since $K = 1$, we omit the subscript $k$. Without loss of generality, we set $r_1 = 0$. Because $\alpha = 0$, $S(\boldsymbol{x}, r_1, s_1) = \sum_{\tau=1}^{T} \delta^{T-\tau} \left(v(x_\tau + s_\tau) - v(s_\tau)\right)$ . Suppose that, in the optimal sequence, Activity $i$ starts in time period $t$ and immediately precedes Activity $j$. In that case, because $x_\tau = x_i$ whenever $\pi_\tau = i$, we obtain

$$\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) = &\sum_{\tau=1}^{t-1} \delta^{T-\tau} \left(v(x_\tau + s_\tau) - v(s_\tau)\right) \\
&+ \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau} \big(v((\tau - t + 1)\, x_i + s_t) \\
&- v((\tau - t)\, x_i + s_t)\big) \\
&+ \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau} \Big(v\big((\tau - t - d_i + 1)\, x_j + d_i\, x_i + s_t\big) \\
&- v\big((\tau - t - d_i)\, x_j + d_i\, x_i + s_t\big)\Big) \\
&+ \sum_{\tau=t+d_i+d_j}^{T} \delta^{T-\tau} \left(v(x_\tau + s_\tau) - v(s_\tau)\right) \\
= &\sum_{\tau=1}^{t-1} \delta^{T-\tau} \left(v(x_\tau + s_\tau) - v(s_\tau)\right) - v(s_t)\, \delta^{T-t} \\
&+ \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau-1}\, v((\tau - t + 1)\, x_i + s_t)(\delta - 1) \\
&+ \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau-1}\, v\big((\tau - t - d_i + 1)\, x_j + d_i\, x_i \\
&+ s_t\big)(\delta - 1) + \delta^{T-t-d_i-d_j}\, v\big(d_j\, x_j + d_i\, x_i + s_t\big) \\
&+ \sum_{\tau=t+d_i+d_j+1}^{T} \delta^{T-\tau} \left(v(x_\tau + s_\tau) - v(s_\tau)\right).
\end{aligned}$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that $S(\boldsymbol{x}, r_1, s_1) - S\big(\tilde{\boldsymbol{x}}, r_1, s_1\big) \geq 0$. Because the terms associated with activities scheduled before $t$ or after $t + d_i + d_j + 1$ are identical across both expressions, we must thus have that

$$
\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) - S(\tilde{\boldsymbol{x}}, r_1, s_1) \\
&= \sum_{\tau=t}^{t+d_i-1} \delta^{T-\tau-1}\, v((\tau - t + 1)\, x_i + s_t)(\delta - 1) \\
&= \sum_{\tau=t+d_i}^{t+d_i+d_j-1} \delta^{T-\tau-1}\, v\big((\tau - t - d_i + 1)\, x_j + d_i\, x_i \\
&+ s_t\big)(\delta - 1) \\
&- \sum_{\tau=t}^{t+d_j-1} \delta^{T-\tau-1}\, v\big((\tau - t + 1)\, x_j + s_t\big)(\delta - 1) \\
&- \sum_{\tau=t+d_j}^{t+d_i+d_j-1} \delta^{T-\tau-1}\, v\big(\big(\tau - t - d_j + 1\big)\, x_i + d_j\, x_j \\
&+ s_t\big)(\delta - 1) \geq 0,
\end{aligned}
$$

which implies, since $v(x)$ is increasing, that $x_i \leq x_j$. ∎

*Proof of Proposition 3:* The proof uses an interchange argument. Throughout the proof, since $K = 1$, we omit the subscript $k$. Because $\delta = 1$ and $\gamma = 0$, $S(\boldsymbol{x}, r_1, s_1) = \sum_{\tau=1}^{T} v(x_\tau - r_\tau) - v(s_1)$ . Suppose first that Activities $i$ and $j$ are not the last ones. Specifically, suppose that, in the optimal sequence, Activity $i$ starts in time period $t$ and immediately precedes Activity $j$, and that Activity $j$ precedes Activity $l$. In that case, because $x_\tau = x_i$ whenever $\pi_\tau = i$, we obtain

$$
\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) = &\sum_{\tau=1}^{t-1} v(x_\tau - r_\tau) + v(x_i - r_t) + v\big(x_j - x_i\big) + v\big(x_l - x_j\big) \\
&+ \sum_{\tau=t+d_i+d_j+d_l}^{T} v(x_\tau - r_\tau) - v(s_1).
\end{aligned}
$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that $S(\boldsymbol{x}, r_1, s_1) - S\big(\tilde{\boldsymbol{x}}, r_1, s_1\big) \geq 0$. Because the terms associated with activities scheduled before $t$ or after $t + d_i + d_j + d_l$ are identical across both expressions, we obtain that

$$
\begin{aligned}
S(\boldsymbol{x}, r_1, s_1) - S\big(\tilde{\boldsymbol{x}}, r_1, s_1\big) \\
&= v(x_i - r_t) + v\big(x_j - x_i\big) + v\big(x_l - x_j\big) - v\big(x_j - r_t\big) \\
&- v\big(x_i - x_j\big) - v(x_l - x_i) \geq 0.
\end{aligned}
$$

We next show that this inequality holds if only if $x_i \leq x_j$.Suppose first that $x_i \leq x_j$. Because $v(x)$ is subadditive, $v(x_j - r_t) \leq v(x_j - x_i) + v(x_i - r_t)$. Similarly, $v(x_l - x_i) \leq v(x_l - x_j) + v(x_j - x_i)$. Moreover, because of loss aversion, when $x_i \leq x_j$, $v(x_j - x_i) \leq - v(x_i - x_j)$. Combining these inequalities yields the desired inequality. Conversely, suppose that $x_i > x_j$. Because $v(x)$ is subadditive, $v(x_i - r_t) \leq v$

$(x_i - x_j) + v(x_j - r_t)$. Similarly, $v(x_l - x_j) \le v(x_l - x_i) + v(x_i - x_j)$. Moreover, because of loss aversion, when $x_i > x_j$, $v(x_j - x_i) < -v(x_i - x_j)$. Combining these inequalities yields the opposite inequality. Hence, $S(\boldsymbol{x}, r_1, s_1) - S(\tilde{\boldsymbol{x}}, r_1, s_1) \ge 0$ implies that $x_i \le x_j$.

Next, suppose that Activities $i$ and $j$ are the last ones. Then,

$$S(\boldsymbol{x}, r_1, s_1) = \sum_{\tau=1}^{t-1} v(x_\tau - r_\tau) + v(x_i - r_t) + v(x_j - x_i) - v(s_1).$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that

$$\begin{aligned} S(\boldsymbol{x}, r_1, s_1) - S(\tilde{\boldsymbol{x}}, r_1, s_1) \\ &= v(x_i - r_t) + v(x_j - x_i) - v(x_j - r_t) - v(x_i - x_j) \\ &\ge 0. \end{aligned}$$

Similar to the argument above for the case where Activities $i$ and $j$ are not the last ones, we can show that this inequality holds if and only if $x_i \le x_j$. Hence, $S(\boldsymbol{x}, r_1, s_1) - S(\tilde{\boldsymbol{x}}, r_1, s_1) \ge 0$ implies that $x_i \le x_j$. ∎

*Proof of Proposition 4:* The proof uses an interchange argument. Throughout the proof, since $K = 1$, we omit the subscript $k$. Because $\delta = \gamma = 1$, $S(\boldsymbol{x}, r_1, s_1) = v(x_T - r_T + s_T) - v(s_1)$. Suppose first that Activities $i$ and $j$ are not the last ones. Specifically, suppose that, in the optimal sequence, Activity $i$ starts in time period $t$ and immediately precedes Activity $j$, and that Activity $j$ precedes Activity $l$. In that case, because $x_\tau = x_i$ whenever $\pi_\tau = i$, we obtain

$$\begin{aligned} x_T - r_T + s_T = x_T - r_t + s_t &+ \sum_{\tau=t}^{T-1} (1-\alpha)^{T-\tau} (x_i - r_t) \\ &+ \sum_{\tau=t+d_i}^{T-1} (1-\alpha)^{T-\tau} (x_j - x_i) \\ &+ \sum_{\tau=t+d_i+d_j}^{T-1} (1-\alpha)^{T-\tau} (x_l - x_j) + \dots. \end{aligned}$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that $S(\boldsymbol{x}, r_1, s_1) - S(\tilde{\boldsymbol{x}}, r_1, s_1) \ge 0$. Because the function $v(x)$ is increasing, this implies that $x_T - r_T + s_T \ge \tilde{x}_T - \tilde{r}_T + \tilde{s}_T$, in which $\tilde{r}_T$ and $\tilde{s}_T$ are the reference point and satiation level in period $T$ corresponding to sequence $\tilde{\boldsymbol{x}}$. Because the terms associated with activities scheduled before $t$ or after $t + d_i + d_j + d_l$ are identical across both expressions, as well as $r_t$ and $x_l$, we must thus have that

$$
\begin{aligned}
(x_T - r_T + s_T) - (\tilde{x}_T - \tilde{r}_T + \tilde{s}_T) \\
&= (x_i - x_j) \\
&\times \Big(\sum_{\tau=t}^{T-1}(1-\alpha)^{T-\tau} - \sum_{\tau=t+d_i}^{T-1}(1-\alpha)^{T-\tau} \\
&- \sum_{\tau=t+d_j}^{T-1}(1-\alpha)^{T-\tau} + \sum_{\tau=t+d_i+d_j}^{T-1}(1-\alpha)^{T-\tau}\Big) \geq 0.
\end{aligned}
$$

After expanding the series, we obtain that

$$
\begin{aligned}
(x_i - x_j) \times \frac{(1-\alpha)^{T-t+1}}{\alpha} \\
\times \left(-1 + (1-\alpha)^{-d_i} + (1-\alpha)^{-d_j} - (1-\alpha)^{-d_i-d_j}\right) \geq 0
\end{aligned}
$$

Using Lemma 1, we obtain that the second term in parentheses is always negative, which implies that $x_i \leq x_j$.

When Activities $i$ and $j$ are the last two activities, we obtain, using a similar logic, that

$$
\begin{aligned}
(x_i - x_j) \times \left(\sum_{\tau=t}^{T-1}(1-\alpha)^{T-\tau} - \sum_{\tau=t+d_i}^{T-1}(1-\alpha)^{T-\tau} - \sum_{\tau=t+d_j}^{T-1}(1-\alpha)^{T-\tau}\right) \\
\geq 0.
\end{aligned}
$$

After expanding the series using the fact that $T - t = d_i + d_j$, we obtain

$$
\begin{aligned}
(x_i - x_j) \times \frac{(1-\alpha)^{d_i+d_j+1}}{\alpha} \\
\times \left(-1 + (1-\alpha)^{-d_i} + (1-\alpha)^{-d_j} - (1-\alpha)^{-d_i-d_j}\right) \geq 0
\end{aligned}
$$

Using Lemma 1, we obtain that the second term in parentheses is always negative, which implies that $x_i \leq x_j$. ∎

*Proof of Proposition 5:* The proof uses an interchange argument. Because $v_k(x) = w_k\, x$ for all $k$, $S(\boldsymbol{x}, \boldsymbol{r}_1, \boldsymbol{s}_1) = \sum_{\tau=1}^{T} \sum_{k=1}^{K} w_k\, \delta^{T-\tau}\, (x_{k,\tau} - r_{k,\tau})$, i.e., the terms in $s_\tau$ cancel each other. Suppose first that Activities $i$ and $j$ are not the last ones. Specifically, suppose that, in the optimal sequence, Activity $i$ starts in time period $t$ and immediately precedes Activity $j$, and that Activity $j$ precedes Activity $l$. In that case, because $x_{k,\ \tau} = x_{k,\ i}$ whenever $\pi_\tau = i$, we obtain

$$
\begin{aligned}
S(\boldsymbol{x},\boldsymbol{r}_1,\boldsymbol{s}_1) = {} & \sum_{\tau=1}^{t-1}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}\left(x_{k,\tau}-r_{k,\tau}\right) + \sum_{\tau=t}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t}\left(x_{k,i}-r_{k,t}\right) \\
& + \sum_{\tau=t+d_i}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i}\left(x_{k,j}-x_{k,i}\right) \\
& + \sum_{\tau=t+d_i+d_j}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i-d_j}\left(x_{k,l}-x_{k,j}\right) \\
& + \ldots .
\end{aligned}
$$

Consider a suboptimal sequence $\tilde{\boldsymbol{x}}$ in which Activities $i$ and $j$ have been permuted. Because $\boldsymbol{x}$ is optimal, we must have that $S(\boldsymbol{x},\boldsymbol{r}_1,\boldsymbol{s}_1) - S(\tilde{\boldsymbol{x}},\boldsymbol{r}_1,\boldsymbol{s}_1) \geq 0$. Because the terms associated with activities scheduled before $t$ or after $t + d_i + d_j + d_l$ are identical across both expressions, as well as $r_{k,\ t}$ and $x_{k,\ l}$, we thus obtain that

$$
\begin{aligned}
S(\boldsymbol{x},\boldsymbol{r}_1,\boldsymbol{s}_1) & - S(\tilde{\boldsymbol{x}},\boldsymbol{r}_1,\boldsymbol{s}_1) \\
& = \sum_{\tau=t}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t}\left(x_{k,i}-x_{k,j}\right) \\
& + \sum_{\tau=t+d_i}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i}\left(x_{k,j}-x_{k,i}\right) \\
& + \sum_{\tau=t+d_j}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t-d_j}\left(x_{k,j}-x_{k,i}\right) \\
& + \sum_{\tau=t+d_i+d_j}^{T}\sum_{k=1}^{K} w_k\,\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i-d_j}\left(x_{k,i}-x_{k,j}\right) \\
\geq 0.
\end{aligned}
$$

Equivalently,

$$
\begin{aligned}
& \left(\sum_{k=1}^{K} w_k\left(x_{k,i}-x_{k,j}\right)\right) \\
& \qquad \times \Big(\sum_{\tau=t}^{T}\delta^{T-\tau}(1-\alpha)^{\tau-t} - \sum_{\tau=t+d_i}^{T}\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i} \\
& \qquad - \sum_{\tau=t+d_j}^{T}\delta^{T-\tau}(1-\alpha)^{\tau-t-d_j} \\
& \qquad + \sum_{\tau=t+d_i+d_j}^{T}\delta^{T-\tau}(1-\alpha)^{\tau-t-d_i-d_j}\Big) \geq 0.
\end{aligned}
$$

After expanding the series, we obtain

$$
\begin{aligned}
\left(\sum_{k=1}^{K} w_k \left(x_{k,i} - x_{k,j}\right)\right) \times & \frac{1}{\delta - (1-\alpha)} \\
& \times \Big( -(1-\alpha)^{T-t+1} + (1-\alpha)^{T-t-d_i+1} \Big) \\
& + (1-\alpha)^{T-t-d_j+1} - (1-\alpha)^{T-t-d_i-d_j+1} + \delta^{T-t+1} \\
& - \delta^{T-t-d_i+1} - \delta^{T-t-d_j+1} + \delta^{T-t-d_i-d_j+1} \Big) \geq 0.
\end{aligned}
$$

Using Lemmas 1 and 2, that the last two terms are nonnegative if and only if $t \leq T + 1 - \frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}+\delta^{-d_i-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}+(1-\alpha)^{-d_i-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$.

When Activities $i$ and $j$ are the last two activities, we obtain, using a similar logic, that

$$
\begin{aligned}
& \left(\sum_{k=1}^{K} w_k \left(x_{k,i} - x_{k,j}\right)\right) \\
& \quad \times \Big(\sum_{\tau=t}^{T} \delta^{T-\tau}(1-\alpha)^{\tau-t} - \sum_{\tau=t+d_i}^{T} \delta^{T-\tau}(1-\alpha)^{\tau-t-d_i} \\
& \quad - \sum_{\tau=t+d_j}^{T} \delta^{T-\tau}(1-\alpha)^{\tau-t-d_j}\Big) \geq 0.
\end{aligned}
$$

After expanding the series, it can be checked that the second term in parentheses is nonnegative if and only if $t \geq T + 1 - \frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$. Because, for any $p$, $q \geq 1$, the function $1 - x^{-p} - x^{-q}$ is increasing in $x$, $1 - \delta^{-d_i} - \delta^{-d_j} \geq 1 - (1-\alpha)^{-d_i} - (1-\alpha)^{-d_j}$ if and only if $\delta \geq 1 - \alpha$. Hence, the term $\frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$ is always negative, and therefore, $t < T + 1 - \frac{\ln\left(\frac{1-\delta^{-d_i}-\delta^{-d_j}}{1-(1-\alpha)^{-d_i}-(1-\alpha)^{-d_j}}\right)}{\ln\left(\frac{1-\alpha}{\delta}\right)}$ for all Activities $i$ and $j$. As a result, we must have that $\sum_{k=1}^{K} w_k \left(x_{k,i} - x_{k,j}\right) \leq 0$ if Activities $i$ and $j$ are the last ones and if Activity $i$ precedes Activity $j$ in the optimal sequence. ∎

*Proof of Proposition 6:* We first show by induction that $x_{T-k} = r_{T-k} + \left(v'\right)^{-1}\left(\frac{\lambda(1+k\alpha)}{\delta^k}\right)$. Consider the Lagrangean function $L((x_1, \ldots, x_T), r_1, 0) = S((x_1, \ldots, x_T), r_1, 0) - \lambda \left(\sum_{t=1}^{T} x_t - B\right)$. Because the second-order optimality condition associated with $x_T$, i.e., $\frac{\partial^2 L((x_1, \ldots, x_T), r_1, 0)}{\partial x_T^2} = v''(x_T - r_T) < 0$, is always satisfied by concavity of $v(x)$, every stationary point defines a global maximum.

Because $x_T = r_T + (v')^{-1}(\lambda)$ satisfies the first-order optimality condition associated with $x_T$, i.e., $\frac{\partial L((x_1,\ldots,x_T),r_1,0)}{\partial x_T} = v'(x_T - r_T) - \lambda = 0$, it is optimal to set $x_T^* = r_T + \left(v'\right)^{-1}(\lambda)$.

Fix $k > 0$ and suppose that it is optimal to set $x_{T-l}^* = r_{T-l} + \left(v'\right)^{-1}\left(\frac{\lambda(1+l\alpha)}{\delta^l}\right)$ for $l = 0, \ldots, k-1$. Using the induction hypothesis, we obtain that

$$\begin{aligned}
&\frac{\partial L\left(\left(x_1,\ldots,x_{T-k},x_{T-k+1}^*,\ldots,x_T^*\right),r_1,0\right)}{\partial x_{T-k}} \\
&\quad = \delta^k\, v'(x_{T-k} - r_{T-k}) \\
&\quad - \alpha\sum_{l=0}^{k-1}\delta^l\,(1-\alpha)^{k-1-l}v'\left(x_{T-l}^* - r_{T-l}\right) - \lambda \\
&\quad = \delta^k\, v'(x_{T-k} - r_{T-k}) - \alpha\sum_{l=0}^{k-1}(1-\alpha)^{k-1-l}(\lambda(1+l\,\alpha)) \\
&\quad - \lambda = \delta^k\, v'(x_{T-k} - r_{T-k}) - \lambda(1+k\,\alpha),
\end{aligned}$$

because

$$\begin{aligned}
&\sum_{l=0}^{k-1}(1-\alpha)^{-l}(1+l\,\alpha) \\
&\quad = \frac{1-(1-\alpha)^{-k}}{1-(1-\alpha)^{-1}} \\
&\quad + \alpha(1-\alpha)^{-1}\frac{1-k\,(1-\alpha)^{-(k-1)} + (k-1)(1-\alpha)^{-k}}{\left(1-(1-\alpha)^{-1}\right)^2} \\
&\quad = \frac{1-\alpha}{\alpha}\left(-1+(1-\alpha)^{-k} + 1 - k\,(1-\alpha)^{-(k-1)}\right. \\
&\quad \left. + (k-1)(1-\alpha)^{-k}\right) \\
&\quad = \frac{1-\alpha}{\alpha}\,k\,(1-\alpha)^{-k}\,(-(1-\alpha)+1\,) = k\,(1-\alpha)^{1-k}.
\end{aligned}$$

Because $\frac{\partial}{\partial x_{T-k}}\left(\frac{\partial L\left(\left(x_1,\ldots,x_{T-k},x_{T-k+1}^*,\ldots,x_T^*\right),r_1,0\right)}{\partial x_{T-k}}\right) = \delta^k\, v''(x_{T-k} - r_{T-k}) < 0$ and because $x_{T-k} = r_{T-k} + \left(v'\right)^{-1}\left(\frac{\lambda(1+k\alpha)}{\delta^k}\right)$ solves $\frac{\partial L\left(\left(x_1,\ldots,x_{T-k},x_{T-k+1}^*,\ldots,x_T^*\right),r_1,0\right)}{\partial x_{T-k}} = 0$, it is optimal to set $x_{T-k}^* = r_{T-k} + \left(v'\right)^{-1}\left(\frac{\lambda(1+k\alpha)}{\delta^k}\right)$. This completes the induction step.

Because $v''(x) < 0$, $x_{T-k}^* - r_{T-k} = \left(v'\right)^{-1}\left(\frac{\lambda(1+k\alpha)}{\delta^k}\right)$ is decreasing in $k$.

Finally, suppose that $v(x) = x^{\beta}$ for some $0 < \beta < 1$ when $x \geq 0$. In that case, $x^*_{T-k} \geq x^*_{T-k-1}$ if and only if $r_{T-k} + \left(\frac{\lambda(1+k\alpha)}{\beta\,\delta^k}\right)^{\frac{1}{\beta-1}} \geq x^*_{T-k-1}$, i.e., if and only if $\left(\frac{\lambda(1+k\alpha)}{\beta\,\delta^k}\right)^{\frac{1}{\beta-1}} \geq (1-\alpha)\left(\frac{\lambda(1+(k+1)\alpha)}{\beta\,\delta^{k+1}}\right)^{\frac{1}{\beta-1}}$, i.e., if and only if $\frac{\left(\frac{\lambda(1+k\alpha)}{\beta\,\delta^k}\right)}{\left(\frac{\lambda(1+(k+1)\alpha)}{\beta\,\delta^{k+1}}\right)} \leq (1-\alpha)^{\beta-1}$, i.e., if and only if $\left(\frac{\delta\,(1+k\alpha)}{(1+(k+1)\alpha)}\right) \leq (1-\alpha)^{\beta-1}$. The left-hand side is increasing in $k$, whereas the right-hand side is constant, so there is at most one crossing. Because the left-hand side is equal to $\left(\frac{\delta}{(1+\alpha)}\right)$ when $k = 0$ and to $\delta$ when $k \to \infty$, and that both values are smaller than $(1-\alpha)^{\beta-1}$, we conclude that $x^*_{T-k} \geq x^*_{T-k-1}$ for all $k$. ∎

*Proof of Proposition 7:* Without loss of generality, we set $r_1 = 0$. Consider the Lagrangean function $L((x_1,\ldots,x_T),0,s_1) = S((x_1,\ldots,x_T),0,s_1) - \lambda\left(\sum_{t=1}^{T} x_t - B\right)$. Because the second-order optimality condition associated with $x_T$, i.e., $\frac{\partial^2 L((x_1,\ldots,x_T),0,s_1)}{\partial x_T^2} = v''(x_T + s_T) < 0$, is always satisfied by concavity of $v(x)$, every stationary point defines a global maximum. Because $x_T = -s_T + (v')^{-1}(\lambda)$ satisfies the first-order optimality condition associated with $x_T$, i.e., $\frac{\partial L((x_1,\ldots,x_T),0,s_1)}{\partial x_T} = v'(x_T + s_T) - \lambda = 0$, it is optimal to set $x^*_T = -s_T + \left(v'\right)^{-1}(\lambda)$.

We next show by induction that $v'\left(x^*_{T-k} + s_{T-k}\right) - (\gamma/\delta)\, v'\left(\gamma\,\left(x^*_{T-k} + s_{T-k}\right)\right) = (1-\gamma)\lambda/\delta^k$ for all $k = 1, \ldots, T-1$. Because

$$\begin{aligned}\frac{\partial L\left(\left(x_1,\ldots,x_{T-1},x^*_T\right),0,s_1\right)}{\partial x_{T-1}} &= \delta\, v'(x_{T-1} + s_{T-1}) + \gamma\,\left(v'\left(x^*_T + s_T\right) - v'(s_T)\right) - \lambda \\ &= \delta\, v'(x_{T-1} + s_{T-1}) + \gamma\,(\lambda - v'(\gamma\,(x_{T-1} + s_{T-1}))) \\ &\quad - \lambda,\end{aligned}$$

we obtain that

$$\begin{aligned}\frac{\partial}{\partial x_{T-1}}\left(\frac{\partial L\left(\left(x_1,\ldots,x_{T-1},x^*_T\right),0,s_1\right)}{\partial x_{T-1}}\right) \\ = \delta\, v''(x_{T-1} + s_{T-1}) - \gamma^2\, v''(\gamma\,(x_{T-1} + s_{T-1})) < 0,\end{aligned}$$

by assumption, and it is thus optimal to set $x^*_{T-1}$ such that $\frac{\partial L\left(\left(x_1,\ldots,x_{T-1},x^*_T\right),0,s_1\right)}{\partial x_{T-1}} = \delta\, v'(x_{T-1} + s_{T-1}) + \gamma\,(\lambda - v'(\gamma\,(x_{T-1} + s_{T-1}))) - \lambda = 0.$

Fix $k > 0$ and suppose that it is optimal to set $x^*_{T-l}$ such that $v'\left(x^*_{T-l} + s_{T-l}\right) - (\gamma/\delta)\, v'\left(\gamma\,\left(x^*_{T-l} + s_{T-l}\right)\right) = (1-\gamma)\lambda/\delta^l$ for all $l = 1, \ldots, k$. Using the induction hypothesis, we obtain that

$$\begin{aligned}
&\frac{\partial L\big(\big(x_1,\ldots,x_{T-k},x^*_{T-k+1},\ldots,x^*_T\big),r_1,s_1\big)}{\partial x_{T-k}}\\
&\quad= \delta^k\, v'(x_{T-k}+s_{T-k})\\
&\quad+\sum_{l=0}^{k-1}\delta^l\,\gamma^{k-l}\left(v'\big(x^*_{T-l}+s_{T-l}\big)-v'(s_{T-l})\right)-\lambda\\
&\quad= \delta^k\, v'(x_{T-k}+s_{T-k})-\delta^{k-1}\,\gamma\, v'(s_{T-k+1})\\
&\quad+\sum_{l=1}^{k-1}\delta^l\,\gamma^{k-l}\left(v'\big(x^*_{T-l}+s_{T-l}\big)-\left(\frac{\gamma}{\delta}\right)v'(s_{T-l+1})\right)\\
&\quad+\gamma^k v'\big(x^*_T+s_T\big)-\lambda\\
&\quad= \delta^k\, v'(x_{T-k}+s_{T-k})-\delta^{k-1}\,\gamma\, v'(s_{T-k+1})\\
&\quad+\sum_{l=1}^{k-1}\gamma^{k-l}\lambda\,(1-\gamma)+\gamma^k\lambda-\lambda\\
&\quad= \delta^k\, v'(x_{T-k}+s_{T-k})-\delta^{k-1}\,\gamma\, v'(s_{T-k+1})+\gamma\,\lambda-\lambda.
\end{aligned}$$

Hence,

$$\begin{aligned}
&\frac{\partial}{\partial x_{T-k}}\left(\frac{\partial L\big(\big(x_1,\ldots,x_{T-k},x^*_{T-k+1},\ldots,x^*_T\big),r_1,s_1\big)}{\partial x_{T-1}}\right)\\
&\quad= \delta^k\, v''(x_{T-k}+s_{T-k})-\delta^{k-1}\,\gamma^2\, v''(\gamma\,(x_{T-k}+s_{T-k}))\\
&\quad< 0,
\end{aligned}$$

and it therefore is optimal to set $x^*_{T-k}$ such that $\frac{\partial L\big(\big(x_1,\ldots,x_{T-k},x^*_{T-k+1},\ldots,x^*_T\big),r_1,s_1\big)}{\partial x_{T-k}}=0$. This completes the induction step.

Because $v'\big(x^*_{T-k}+s_{T-k}\big)-\left(\frac{\gamma}{\delta}\right)v'\big(\gamma\,\big(x^*_{T-k}+s_{T-k}\big)\big)=\frac{(1-\gamma)\lambda}{\delta^k}<\frac{(1-\gamma)\lambda}{\delta^{k+1}}=v'\big(x^*_{T-k-1}+s_{T-k-1}\big)-\left(\frac{\gamma}{\delta}\right)v'\big(\gamma\,\big(x^*_{T-k-1}+s_{T-k-1}\big)\big)$ and because the function $v'(x)-\left(\frac{\gamma}{\delta}\right)v'(\gamma\,x)$ is decreasing by assumption, we obtain that $x^*_{T-k}+s_{T-k}\geq x^*_{T-k-1}+s_{T-k-1}$ for any $k=1,\ldots,T-1$. Moreover, because $(1-\gamma)v'\big(x^*_T+s_T\big)=(1-\gamma)\lambda=\delta\,v'\big(x^*_{T-1}+s_{T-1}\big)-\gamma\,v'\big(\gamma\,\big(x^*_{T-1}+s_{T-1}\big)\big)<(\delta-\gamma)\,v'\big(x^*_{T-1}+s_{T-1}\big)\leq(1-\gamma)\,v'\big(x^*_{T-1}+s_{T-1}\big)$, since $v'(x)>0$, $v''(x)>0$, and $\delta\leq 1$; therefore, $x^*_T+s_T>x^*_{T-1}+s_{T-1}$.

Finally, suppose that $v(x)=x^\beta$ for some $\ln\delta/\ln\gamma<\beta<1$ when $x\geq 0$. In that case, $x^*_{T-k}=-s_{T-k}+\left(\frac{\delta^{k-1}\,\beta\,(\delta-\gamma^\beta)}{\lambda\,(1-\gamma)}\right)^{\frac{1}{1-\beta}}$ for $k=1,\ldots,T-1$ and $x^*_T=-s_T+\left(\frac{\beta}{\lambda}\right)^{\frac{1}{1-\beta}}$. Suppose that $T\geq 3$. Then, $x^*_T\geq x^*_{T-1}$ if and only if $\left(\frac{\beta}{\lambda}\right)^{\frac{1}{1-\beta}}\geq x^*_{T-1}+s_T=x^*_{T-1}+\gamma\big(x^*_{T-1}+s_{T-1}\big)=(1+\gamma)\big(x^*_{T-1}+s_{T-1}\big)-s_{T-1}=$

$(1+\gamma)\left(x_{T-1}^*+s_{T-1}\right)-\gamma\left(x_{T-2}^*+s_{T-2}\right)=(1+\gamma)\left(\frac{\beta\left(\delta-\gamma^\beta\right)}{\lambda\,(1-\gamma)}\right)^{\frac{1}{1-\beta}}-\gamma(\delta\,\beta\ \frac{\left(\delta-\gamma^\beta\right)}{\lambda\,(1-\gamma))^{\frac{1}{1-\beta}}}$.
Hence, $x_T^*\geq x_{T-1}^*$ if and only if $1\geq\left((1+\gamma)-\gamma\delta^{\frac{1}{1-\beta}}\right)\left(\frac{\left(\delta-\gamma^\beta\right)}{(1-\gamma)}\right)^{\frac{1}{1-\beta}}$, which is always true since $\left((1+\gamma)-\gamma\delta^{\frac{1}{1-\beta}}\right)\left(\frac{\left(\delta-\gamma^\beta\right)}{(1-\gamma)}\right)^{\frac{1}{1-\beta}}\leq((1+\gamma)-\gamma)\left(\frac{\left(1-\gamma^\beta\right)}{(1-\gamma)}\right)^{\frac{1}{1-\beta}}\leq 1$. Similarly, suppose that $T-k\geq 3$. Then, $x_{T-k}^*\geq x_{T-k-1}^*$ if and only if $\left(\frac{\delta^{k-1}\,\beta\,\left(\delta-\gamma^\beta\right)}{\lambda\,(1-\gamma)}\right)^{\frac{1}{1-\beta}}\geq x_{T-k-1}^*+s_{T-k}=x_{T-k-1}^*+\gamma\left(x_{T-k-1}^*+s_{T-k-1}\right)=(1+\gamma)$ $\left(x_{T-k-1}^*+s_{T-k-1}\right)-s_{T-k-1}=(1+\gamma)\left(x_{T-k-1}^*+s_{T-k-1}\right)-\ \gamma\left(x_{T-k-2}^*+s_{T-k-2}\right)=$ $(1+\gamma)\left(\frac{\delta^k\,\beta\,\left(\delta-\gamma^\beta\right)}{\lambda\,(1-\gamma)}\right)^{\frac{1}{1-\beta}}-\gamma\left(\frac{\delta^{k+1}\,\beta\,\left(\delta-\gamma^\beta\right)}{\lambda\,(1-\gamma)}\right)^{\frac{1}{1-\beta}}$. Hence, $x_{T-k}^*\geq x_{T-k-1}^*$ if and only if $1\geq\delta^{\frac{1}{1-\beta}}\left((1+\gamma)-\gamma\delta^{\frac{1}{1-\beta}}\right)$, which is always true. ∎

*Proof of Proposition 8:* The proof proceeds by backward induction by showing that $W_t(r_t)=\sqrt{\left(1+\sum_{\tau=1}^{T-t}\delta^{-2\tau}\right)\,r_t\,(1-r_t)}$ for all $t$. To initialize the induction step, we have $W_T(r_T)=\max_{\bar{x}_T\geq r_T\geq\underline{x}_T}\sqrt{\frac{r_T-\underline{x}_T}{\bar{x}_T-\underline{x}_T}\$\$\left(\bar{x}_T-r_T\right)^2+\frac{\bar{x}_T-r_T}{\bar{x}_T-\underline{x}_T}\left(r_T-\underline{x}_T\right)^2}=$ $\sqrt{\left(\bar{x}_T-r_T\right)\left(r_T-\underline{x}_T\right)}$. Because the objective function is increasing in $\bar{x}_T$ and decreasing in $\underline{x}_T$, it is optimal to set $\bar{x}_T=1$ and $\underline{x}_T=0$. Hence, $W_T(r_T)=\sqrt{r_T\,(1-r_T)}$. Fix $t<T$ and suppose that $W_{t+1}(r_{t+1})=\sqrt{\left(1+\sum_{\tau=1}^{T-t-1}\delta^{-2\tau}\right)\,r_{t+1}\,(1-r_{t+1})}$. In that case,

$$\begin{aligned}
W_t(r_t)=&\max_{\bar{x}_t\geq r_t\geq\underline{x}_t}\sqrt{\frac{r_t-\underline{x}_t}{\bar{x}_t-\underline{x}_t}\left(\bar{x}_t-r_t\right)^2+\frac{\bar{x}_t-r_t}{\bar{x}_t-\underline{x}_t}\left(r_t-\underline{x}_t\right)^2}\\
&+\delta^{-1}\frac{r_t-\underline{x}_t}{\bar{x}_t-\underline{x}_t}\,W_{t+1}\left(\bar{x}_t\right)+\delta^{-1}\frac{\bar{x}_t-r_t}{\bar{x}_t-\underline{x}_t}W_{t+1}\left(\underline{x}_t\right)\\
&=\max_{\bar{x}_t\geq r_t\geq\underline{x}_t}\sqrt{\left(\bar{x}_t-r_t\right)\left(r_t-\underline{x}_t\right)}\\
&+\frac{r_t-\underline{x}_t}{\bar{x}_t-\underline{x}_t}\sqrt{\left(\sum_{\tau=1}^{T-t}\delta^{-2\tau}\right)\,\bar{x}_t\,\left(1-\bar{x}_t\right)}\\
&+\frac{\bar{x}_t-r_t}{\bar{x}_t-\underline{x}_t}\sqrt{\left(\sum_{\tau=1}^{T-t}\delta^{-2\tau}\right)\,\underline{x}_t\,\left(1-\underline{x}_t\right)}.
\end{aligned}$$

Taking the first-order optimality conditions yields that $\bar{x}_t = \frac{1}{2} + \sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1}{1 + \left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)} r_t(1 - r_t)}$ and $\underline{x}_t = \frac{1}{2} - \sqrt{\left(r_t - \frac{1}{2}\right)^2 + \frac{1}{1 + \left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)} r_t(1 - r_t)}$. Substituting these values into the objective function yields:

$$
\begin{aligned}
&W_t(r_t) \\
&= \sqrt{\frac{1}{1 + \left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)} r_t(1 - r_t)} \\
&+ \sqrt{\left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)\left(\frac{1}{4} - \left(r_t - \frac{1}{2}\right)^2 - \frac{1}{1 + \left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)} r_t(1 - r_t)\right)} \\
&= \sqrt{\left(1 + \left(\sum_{\tau=1}^{T-t} \delta^{-2\tau}\right)\right) r_t(1 - r_t)},
\end{aligned}
$$

completing the induction step. To see that this solution is indeed optimal, note that $W_t(r_t)$ corresponds to the optimal solution of the problem of allocation a total variance $r_t(1 - r_t)$ across the $T - t + 1$ remaining periods so as to maximize $\sum_{\tau=t}^{T} \delta^{t-\tau} \sqrt{v_\tau}$ subject to $\sum_{\tau=t}^{T} v_\tau \le r_t(1 - r_t)$ (Ely et al. 2015, online appendix). ∎

*Proof of Proposition 9:* The proof proceeds by backward induction. In period $T$, $W_T(r_T) = \max_{\bar{x}_T \ge r_T \ge \underline{x}_T} \frac{r_T - \underline{x}_T}{\bar{x}_T - \underline{x}_T} \left(\bar{x}_T - r_T\right) + \frac{\bar{x}_T - r_T}{\bar{x}_T - \underline{x}_T} \left(r_T - \underline{x}_T\right)$. Because the objective function is increasing in $\bar{x}_T$ and decreasing in $\underline{x}_T$, it is optimal to set $\bar{x}_T = 1$ and $\underline{x}_T = 0$. Hence, $W_T(r_T) = 2r_T(1 - r_T)$. Therefore, in period $T - 1$,

$$
\begin{aligned}
W_{T-1}(r_{T-1}) = \max_{\bar{x}_{T-1} \ge r_{T-1} \ge \underline{x}_{T-1}} &\frac{r_{T-1} - \underline{x}_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} \left(\bar{x}_{T-1} - r_{T-1}\right) \\
&+ \frac{\bar{x}_{T-1} - r_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} \left(r_{T-1} - \underline{x}_{T-1}\right) \\
&+ \delta^{-1} \frac{r_{T-1} - \underline{x}_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} W_T\left(\bar{x}_{T-1}\right) \\
&+ \delta^{-1} \frac{\bar{x}_{T-1} - r_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} W_T\left(\underline{x}_{T-1}\right) \\
&= \max_{\bar{x}_{T-1} \ge r_{T-1} \ge \underline{x}_{T-1}} 2 \frac{r_{T-1} - \underline{x}_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} \left(\bar{x}_{T-1} - r_{T\_1}\right) \\
&+ 2\, \delta^{-1} \Big( \frac{r_{T-1} - \underline{x}_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} \bar{x}_{T-1} \left(1 - \bar{x}_{T-1}\right) \\
&+ \frac{\bar{x}_{T-1} - r_{T-1}}{\bar{x}_{T-1} - \underline{x}_{T-1}} \underline{x}_{T-1} \left(1 - \underline{x}_{T-1}\right)\Big).
\end{aligned}
$$

Taking the first-order optimality conditions with respect to $\underline{x}_{T-1}$ and $\bar{x}_{T-1}$ (and ignoring the suboptimal non-informative solutions) yields the following solution: $\underline{x}_{T-1} = r_{T-1} - \delta/4$ and $\bar{x}_{T-1} = r_{T-1} + \delta/4$ if $r_{T-1} \in \left[\frac{\delta}{4}, 1 - \frac{\delta}{4}\right]$, $\underline{x}_{T-1} = 0$ and $\bar{x}_{T-1} = \sqrt{\delta\, r_{T-1}}$ if $r_{T-1} \in \left[0, \frac{\delta}{4}\right]$, and $\underline{x}_{T-1} = 1 - \sqrt{\delta\,(1 - r_{T-1})}$ and $\bar{x}_{T-1} = 1$ if $r_{T-1} \in \left[1 - \frac{\delta}{4}, 1\right]$. Hence,

$$
\begin{aligned}
&W_{T-1}(r_{T-1}) \\
&= \begin{cases}
2r_{T-1}(1+\delta) - 4r_{T-1}\sqrt{\delta\, r_{T-1}} & \text{if } r_{T-1} \in \left[0, \dfrac{\delta}{4}\right] \\
\delta^{-1} 2r_{T-1}(1 - r_{T-1}) + \dfrac{\delta}{8} & \text{if } r_{T-1} \in \left[\dfrac{\delta}{4}, 1 - \dfrac{\delta}{4}\right] \\
2(1 - r_{T-1})(1+\delta) - 4(1 - r_{T-1})\sqrt{\delta\,(1 - r_{T-1})} & \text{if } r_{T-1} \in \left[1 - \dfrac{\delta}{4}, 1\right].
\end{cases}
\end{aligned}
$$

Consider next period $T - 2$:

$$
\begin{aligned}
W_{T-2}(r_{T-2}) = \max\nolimits_{\bar{x}_{T-2} \ge r_{T-2} \ge \underline{x}_{T-2}} & \frac{r_{T-2} - \underline{x}_{T-2}}{\bar{x}_{T-2} - \underline{x}_{T-2}} \left(\bar{x}_{T-2} - r_{T-2}\right) \\
& + \frac{\bar{x}_{T-2} - r_{T-2}}{\bar{x}_{T-2} - \underline{x}_{T-2}} \left(r_{T-2} - \underline{x}_{T-2}\right) \\
& + \delta^{-1} \frac{r_{T-2} - \underline{x}_{T-2}}{\bar{x}_{T-2} - \underline{x}_{T-2}} W_{T-1}\left(\bar{x}_{T-2}\right) \\
& + \delta^{-1} \frac{\bar{x}_{T-2} - r_{T-2}}{\bar{x}_{T-2} - \underline{x}_{T-2}} W_{T-1}\left(\underline{x}_{T-2}\right).
\end{aligned}
$$

When $r_{T-2} \in \left[\frac{\delta+\delta^2}{4}, 1 - \frac{\delta+\delta^2}{4}\right]$, the function is maximized at $\underline{x}_{T-2} = r_{T-2} - \delta^2/4$ and $\bar{x}_{T-2} = r_{T-2} + \delta^2/4$. ∎

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# Chapter 7
# A Human-Centred, Multidisciplinary, and Transformative Approach to Service Science: A Service Design Perspective

**Daniela Sangiorgi, Filipe Lima, Lia Patrício, Maíra Prestes Joly, and Cristina Favini**

**Abstract** The increasing complexity and human centeredness of service systems raises new challenges to decision makers, requiring the integration of multidisciplinary efforts while addressing the dynamic reconfiguration of actors for value co-creation. This chapter uses a case study investigation into the practice of an Italian service design agency to expand on the understanding of service design as a human centred, multidisciplinary, and transformative approach for service system innovation. The study illustrates how service design can move from being a disciplinary field to become an overarching approach and a cultivated horizontal skill able to favour multidisciplinary integration; also the evolution in the understanding of service from a given market offering or output, to a dynamic condition of value exchange and co-creation, qualifies service design as an "accompanying" service for clients in their transformation journey that enables the collaborative co-creation of value; as a result of this exploratory case study, service design is depicted as a continuing, collaborative and flexible innovation approach that constantly adjusts depending on the level of engagement and alignment of the key partners and the need to nurture the evolving dynamics of value co-creation for service system transformation.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_7

**Keywords** Service science · Service design · Service system transformation · Multidisciplinarity

## 7.1 Introduction

The service sector has become increasingly important in world economies, representing more than 70% of production and employment in western countries (CIA 2018), and as such, service innovation has become a strategic priority. Initial service research efforts more than 30 years ago advocated that services were different from goods, being characterized by their intangibility, heterogeneity, inseparability and perishability, therefore requiring a differentiated approach (Parasuraman, Zeithaml et al. 1985). More recent approaches adopt a broader perspective defining service as the application of competences (knowledge and skills) by one entity for the benefit of another (Vargo and Lusch 2004, 2008) whether it is a customer, employee, an organisation or another service system in general. From this Service-Dominant Logic perspective, value is not pre-produced but is co-created by both the customer and the provider, and the distinction between goods and services become blurred. This service approach means that companies, whether in the service or manufacturing sector, should design their offerings to enable their customers to co-create their experiences in a flexible way, with the customer playing an active role in this process.

However, in spite of the growth of the service sector in the world economies and the evolution of service-dominant logic, service research was concentrated on academic areas such as management, engineering, and design. Moreover, competences and research in service innovation were dispersed (Chesbrough and Sphorer 2006). To address the complexity of service systems, Service Science emerged as an integrative area of study, defined as an interdisciplinary field of inquiry focused on fundamental science, models, theories, and applications to drive service innovation and well-being through co-creation of value (Ostrom, Bitner et al. 2010). Service Science combines business and technology understanding, integrating multiple disciplines such as management, engineering and design, to create the basis for systemic service innovation (Maglio and Spohrer 2008). One of Service Science key challenges is therefore the integration of this wide knowledge base to enhance service system innovation and transformation (Sphorer and Kwan 2009), adopting Service-Dominant Logic that views service as the application of resources for the benefit of another party (Vargo and Lusch 2004, 2008, 2016).

On another side, Service Science has been defined as the study of service systems and of the co-creation of value within complex constellations of integrated resources (Vargo, Maglio et al. 2008). Service systems are considered the basic unit of analysis of Service Science, defined as the configuration of people, technologies, and other resources that interact with other service systems to create mutual value (Maglio et al. 2009). Service systems co-create value directly and indirectly with other service system entities, and can be individuals, families, organisations, cities or

nations, varying in their level of complexity (Spohrer and Maglio 2010). Developing approaches able to support the transformation of complex service systems is another fundamental challenge. In particular, the centrality of people in understanding and transforming service systems has gained ground in Service Science. However, how this human-centeredness can be furthered in practice is lacking research.

With this chapter, we explore the potential role of Design for service system transformation, which has been added as a field to Service Science, a term now used to indicate the integration of Service Science, Management, Engineering and Design (Sphorer and Kwan 2009). Service design was originally identified with a specific stage within a new service development process (Edvardsson et al. 2000). In the 1990s it emerged also as a disciplinary field originating from the field of design studies. Now a renewed interest in service innovation, in particular in the context of a growing complexity of service systems, has expanded the role of service design toward the overall process, considering 'leveraging Service Design' as one of the research priorities in Service Research (Ostrom et al. 2015). Service design is described as a human-centred, collaborative, creative and iterative approach to service innovation (Meroni and Sangiorgi 2011; Blomkvist et al. 2011), which has roots in design practice and theory. There is agreement that this approach and its methods need to "broaden their role" in new service development and service innovation (Ostrom et al. 2015; Sangiorgi et al. 2015; Yu and Sangiorgi 2018), guiding the integration of multiple contributions from service marketing, operations and information technologies (Patrício, Gustafsson et al. 2018). How this can happen in practice though has not been studied, apart from few action research projects focused on the development of methods (Patrício, Pinho et al. 2018; Teixeira et al. 2017).

The guiding question for this chapter has therefore been "how the human-centred service design approach can be applied and expanded to integrate multi-disciplinary teams instilling change and transformation in complex service systems". To address this question, we have been studying how the exemplary case of a large Italian consulting agency has evolved to become a service design company, developing a peculiar multidisciplinary and transformational approach to service system innovation. After an introduction of the evolution of service science and a discussion of the need to strengthen its multidisciplinary and human-centred approach, the chapter introduces service design as a field and innovation practice, followed by an illustrative case study, which informs our understanding and propositions on the role of service design as a human centred, multidisciplinary, and transformative approach for service science.

## 7.2 The Need for a Human-Centred, Integrative and Transformative Approach to Service Systems

Service Science has increasingly recognized that service systems are complex and dynamically self-adjusting, reconfiguring themselves as they iteratively co-create value (Vargo and Lusch 2011). Moreover, more simple service systems such as

families or organisations function within larger value networks and ecosystems, highlighting the nested, networked structure of service systems (Spohrer et al. 2012).

Within this scenario, technology has increased the complexity of service systems. Smart technologies, including mobile, location-based, and wearable devices, are creating a revolutionary, ubiquitous interaction context. The Internet of Things is also leading to the collection of huge and continuous streams of big data with the potential to affect consumers, businesses, and societies in unforeseen ways (Wünderlich et al. 2015). This represents a new context of service, characterized by a many-to-many, interconnected world, where people and devices are empowered by a constant flow of information and by the results of data analytics (Ostrom et al. 2015). In these complex service systems such as urban centres, designing and arranging the multiple entities for value co-creation represents a huge design challenge, which Service Science can address by modelling and simulating these complex service system interactions and reconfigurations (Kieliszewski et al. 2012).

### *7.2.1 Human-Centred Service Systems*

More recently, Service Science has called for a more human-centred approach to the study of service systems, highlighting the importance of Human-Centred Service Systems (HCSSs). HCSSs are configurations of people, information and technology, dominated by human behaviour, human cognition, human emotions, and human needs (Maglio et al. 2015; Breidbach et al. 2016). Service systems integrate people, technologies, information and organisations that interact and coordinate action to generate mutual value. As such, service systems are considered as fundamentally human-centred rather than goods- or technology-centred (Maglio 2014). Service systems are human-centred as they involve people with different roles, using information and capabilities enabled by the service, and interact through different forms (Medina-Borja 2015).

In HCSSs, it is crucial to understand the role of people, and how many-to-many interactions among different system actors lead to emergent behaviours that cannot be anticipated beforehand (Maglio et al. 2015). The increasing complexity and human-centeredness of service systems raises new challenges to decision makers, requiring the integration of multidisciplinary efforts while addressing the dynamic reconfiguration of actors for value co-creation. This increasing complexity and the evolution of service science have called for transdisciplinary approaches for examining and transforming business, spanning disciplines such as information systems, management, design, among others (Lusch et al. 2016). Within this context, new approaches are needed, able to (1) integrate multiple methods and ultimately multidisciplinary knowledge; to effectively (2) understand and transform complex human-centred service systems (Maglio et al. 2015).

### 7.2.2 *Integration of Multidisciplinary Knowledge and Methods*

Service Science involves a wide range of disciplines (e.g. Operations Research, Industrial Engineering, Marketing, Computer Science, Psychology, Information Systems, Design), with the aim of understanding and designing solutions for service systems through different perspectives. In this sense, innovating in service systems requires the integration of multidisciplinary knowledge, in order to adapt a set of multiple lenses "to consider how interactions of people, technology, organisations, and information create value in various contexts and under various conditions" (Maglio 2013, p. 85).

There is a need to integrate competences at the level of specialized disciplines to enhance the design for service systems. "For example, while operations research and industrial engineering often model people waiting in queues, more realistic understanding of people as emotional and psychological beings that can learn and adapt over time, is lacking" (IfM and IBM 2007, p. 08). The authors highlight the importance of leaders in both practice and academia to encourage interdisciplinary work and to provide guidance to reduce risks when moving outside a specialized area. Interdisciplinary work can be facilitated at the project level, by creating cross-functional teams to collaborate, as well as at the business level, motivating professionals to learn enough about each other's perspectives (e.g. concepts, methodologies, etc.) in order to achieve effective and productive work. In this sense, adaptive innovators with a service mind set are needed, with the ability to think across disciplines in the many project roles, building consensus across inter-organisational boundaries and cultures. These are T-shaped professionals, "who can work effectively in project teams across discipline and functional silos, as adaptive innovators with a good background in the fundamentals of service innovation" (IfM and IBM 2007, p. 12).

Sphorer and Kwan (2009) claim service scientists should be T-shaped professionals, by being specialized in a specific field (being able to contribute with expert thinking skills), as well as versed in a wide set of service areas (e.g. Marketing, Operations, Design, Computing, etc.), in order to work effectively in multidisciplinary teams. The authors position two levels of skills from a T-shaped professional: expert thinking skills, also known as contributory expertise; and complex communication skills, also known as interactional expertise. Likewise, the authors refer to T-shaped professionals as adaptive innovators, suggesting that they can learn and adapt more rapidly to the changing needs of business.

Therefore, new knowledge is waiting to be built at the intersection space between disciplines (Medina-Borja 2015), in order to create innovative solutions for service systems. In this context, T-shaped professionals, cross-functional teams and a cross-functional learning process at the business level are seen as facilitators for this integration to happen in practice.

### 7.2.3 Service System Transformation

The concept of transformation in Service Science has been associated with business and organisational change, as well as to the innovation of complex service systems. During an IBM 2-day summit titled "Architecture of Business Demand" with academics in the fields of business, operations research and technology, the new discipline—"services sciences"—was described as a "business transformation science," since it aimed to explore the current and future processes of business as well as its human, technological and strategic elements (IBM Research 2005, p. 8).

Recently the transformation of businesses has been discussed, drawing upon the conceptualization of Service Dominant logic (Vargo and Lusch 2004, 2016, 2008) to illustrate a relevant shift in the assumptions related to value creation. For example, Maglio & Spohrer (2008, p. 19) have stated that "service-dominant logic might provide just the right perspective, vocabulary, and assumptions on which to build a theory of service systems, their configurations, and their modes of interaction". The conceptualization of Service-dominant (S-D) logic is a service centred alternative to the mainstream Goods-dominant logic (G-D) paradigm; here value creation is understood as embedded in solutions (goods or services) that are developed by firms and then exchanged for money (this is to say value in exchange). The proposal of S-D logic suggests instead that businesses should adopt a customer point of view, in which value is determined when solutions (goods or services) are used (or consumed) by customers (value in use) (Vargo and Lusch 2004). Therefore, this conceptualization of value changes the focus from the provider point of view to the customer point of view, and from manufacturing processes to usage/consumption processes. Service Science is therefore pointing toward an understanding and development of business transformation that suggest a reinforced customer orientation.

In order to improve the understanding of the transformation processes in service systems (Spohrer, Maglio, Bailey, and Gruhl 2007), service researchers are searching for new theoretical lenses. Recently scholars (Edvardsson and Tronvoll 2013; Lusch and Nambisan 2015; Koskela-Huotari et al. 2016) are starting to adopt the institutional theory perspective (Lawrence and Suddaby 2006; Thornton and Ocasio 2008). According to the institutional perspective, change can be captured through the concepts of "institutional logic" and "institutional work". Institutional logic has been defined as "the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" (Thornton and Ocasio 2008, p. 804). Thus, the concept of institutional logic highlights that social structures comprehending shared assumptions, beliefs, and values regulate actor's behaviours. In other words, this concept exerts a downward influence, from higher to lower levels of the service system. At the same time, research in this field also recognizes that individual actors have agency and can impact the same institutions that affect them by engaging in institutional work. Institutional work in this sense means "purposive actions aimed at creating, maintaining and disrupting institutions" (Lawrence, Suddaby, and Leca

2011, p. 52). Consequently, this perspective also considers an upward influence from lower to higher levels of the service system. A core idea of the institutional theory is that of "embedded agency" (Thornton and Ocasio 2008), meaning that decisions and consequences are results of an interdependency between institutional structure and individual agency (Thornton and Ocasio 1999).

Viewed from an institutional logic, transformation in service systems is dependent on actors and institutions. This idea is aligned with recent service research suggesting that changes in both resources and social structures are sources of service system innovation (Edvardsson and Tronvoll 2013). Nevertheless, it has been observed that the effect of actors and institutions is not precisely the same. While institutions might, in general, be supporting conformity in a system, actor's agency and creative capacity might be leading towards change. This tension between compliance and change forces, captured by the embedded agency paradox, is one of the avenues for inquiry which gathers the interest of research (Garud, Hardy, and Maguire 2007). In other words, it is important to understand how actors can transform established service systems regulated by institutions.

This short review of literature is pointing toward a fundamental area of research and experimentation for Service Science: the development of a human-centred (able to understand the role of people in HCSS), multidisciplinary (able to integrate multidisciplinary knowledge) and transformative (able to support service system transformation) approach to service innovation. In the next section, we will introduce service design as a field of practice that can address this gap of knowledge and practice.

## 7.3 Service Design as Human-Centred, Integrative and Transformative Approach

This chapter introduces service design, reviewing the core studies that support its conceptualization as a human-centred, multidisciplinary and transformative approach to service innovation. While motivating service design strengths and potentials, we also highlight the key gaps in literature that have motivated our exploratory case study research into the practice of a representative Italian service design agency, named Logotel.

### *7.3.1 Human-Centred Design Approach*

As a new disciplinary area in Design (Manzini 1993; Erlhoff et al. 1997; Pacenti 1998), service design has initially adopted and adapted knowledge and tools mainly from the fields of service marketing and operations (Shostack 1984), interaction and experience design (Holmlid 2007; Pacenti 1998), and participatory design

(Greenbaum and Kyng 1991; Schuler and Namioka 1993). Interpreting services as complex interfaces to the user made up of people, products, information and places (Pacenti 1998), service design has originally focused on designing usable, pleasurable and effective service interfaces and interactions. Particular emphasis has been given on the capabilities of designers to understand, map and communicate customer experiences (Stigliani and Fayard 2010). This focus on services as complex interfaces, allowed designers to apply key competences from interaction design for the understanding of human experiences and the design of better customer journeys (Sangiorgi 2009). In this ambit, designers have adapted methods coming from anthropology, interaction and experience design as well as service marketing.

From anthropology, designers have derived approaches to study users and staff in their contexts. Beyond the well-known ethnographic approaches of participant observation and interviews, recurrent applied methods are: e.g. “shadowing”, where a researcher closely follows a subject over a period of time to study what the person actually does in her daily life and not what her role suggests (Quinlan, 2008); or “design probes”, a form of self-documentation technique, where users receive a probe kit with a set of materials and tasks, to contribute to data collection or to provide inspiration for designers (Mattelmäki 2006).

From interaction design, service designers are applying methods to visualise user data and processes: e.g. “persona”, fictional and archetypical characters that represent distinct groupings of behaviours, goals and motivations that emerged during the research phase (Cooper 1999); or “use cases”, stories representing “all the ways of using a system to achieve a particular goal for a particular user” (Jacobson, Spence, and Bittner 2011, p. 14). Similarly, from service marketing, designers have adopted the concept of customer journeys to make service interactions and experiences tangible and discussable, in particular within collaborative processes (see Fig. 7.1).

The fundamental role of people in co-producing services has also motivated the application of collaborative design approaches and methods, originating from the field of Participatory Design (Schuler and Namioka 1993; Greenbaum and Kyng 1991). Participatory Design is an evolving area of research and practice exploring effective modes to enable user participation during the design process, originally concerned with the implications of introducing computer systems at work.

Based on this tradition, service designers have been playing the facilitation role within co-design workshops, inheriting the principles and formats of design games (Brandt 2006), and acting techniques (Brandt and Grunnet 2000) as used in experience prototyping (Buchenau and Fulton Suri 2000). Design games are intended as a metaphoric framework for organising participation and enhancing dialogue during collaborative design processes (Brandt 2006). They engage participants in a game-like process using props, following some rules (turn taking, progression, tasks, etc.) and adopting a visual aesthetics often related to the context of designing (see Fig. 7.2). Acting techniques are instead applied during co-design processes to allow participants to simulate and physically explore existing or future use of products and services, using simple or more elaborated props (Brandt and Grunnet 2000).

**Fig. 7.1** Example of service interaction design tool: customer journey map (source: 'Design for co-production of healthcare' project, Politecnico di Milano (The research project "Design for co-production of healthcare", funded by Politecnico di Milano (FARB 2015) and led by Dr. Daniela Sangiorgi, investigated the role of design to enhance the co-production of mental healthcare services (https://medium.com/recovery-co-lab)))

**Fig. 7.2** Example of participatory design game exploring levels of urgency in healthcare (source: "Design in Practice project", ImaginationLancaster (https://Imagination.lancs.ac.uk/activities/Design_Practice))

These approaches have been fundamental in the exploration of innovation processes able to enhance the co-creation of public services (Sangiorgi 2015).

These dual dimensions of understanding and engaging people in the design for better service experiences, are what qualifies the human-centredness of designers' work and contribution to service innovation:

> *a human centred design approach to services manifests itself in the capacity and methods to investigate and understand people's experiences, interactions and practices as main sources of inspiration for redesigning or imagining new services [. . .] On another level a human centred approach to services manifests itself in the capacity to engage people in the design and transformation processes* (Meroni and Sangiorgi 2011, p. 203)

This human-centeredness of service design is the quality that has been more considered and recognised within the field of service research; less documented and acknowledged is instead the ability to enable multidisciplinary work or transformational processes.

### *7.3.2 Integrative and Multidisciplinary Approach*

Design has been proposed as an example of 'integrative discipline', able to address complex and wicked problems by integrating knowledge from different fields: "The designer establishes a principle of relevance for knowledge from the arts and sciences, determining how such knowledge may be useful to design thinking in a particular circumstance without immediately reducing design to one or another of these disciplines" (Buchanan 1992, p. 18).

In the specific context of service design, the integration of knowledge has been explored considering contributions from service marketing, operations, information systems (Patricio and Fisk 2013) and interaction design (Pacenti 1998; Holmlid 2007). These areas contribute with complementary perspectives on designing for service (Sangiorgi and Prendiville 2017), bringing together contributions such as the value proposition offered to the customer (Edvardsson et al. 2000), service interfaces that embody service offerings (Secomandi and Snelders 2011), service operations (Hill, Collier et al. 2002), supportive technologies that fuel service innovation (Kieliszewski et al. 2012), and design thinking and participatory design approaches that use visual and co-design methods to explore and generate service ideas (Kimbell 2011). However, multidisciplinary contributions have been dispersed across fields, which results in different concepts and approaches to service design.

On another level, there has been a growing interest in service design as an approach that could be transferred to and applied by other disciplines or in general within organisations to change their mind-set and innovation practices, in a multidisciplinary setting. Design qualities have attracted attention in particular from change management disciplines that have been questioning organisational developments' ability to create evidence of impact on planned change (Bate and Robert 2007); or service marketing studies looking for strategies to develop

customer-centred businesses (Edvardsson 2011); or within creativity and innovation studies (Tether 2009). But when applying design approaches in a multidisciplinary context, issues of compatibility and collaboration have been raised (Robert and Macdonald 2017) as well as concerns related to the preservation of the original qualities of designers' contributions: e.g. adequate use of ideation tools, recognition of the aesthetic value, or the risk to reduce design to a toolkit. The difficulty to translate and effectively apply "designerly" approaches to service innovation is still an area of debate.

This dual interest to converge and integrate multidisciplinary knowledge into service design on one side, and to adapt "designerly" approaches to service innovation on the other side, justifies the search for exemplar studies that could inform this conversation.

### *7.3.3 Transformative Potential*

The importance of understanding and engaging people in service design to improve service experience, has been the entry point for designers into service organisations and the most renowned quality of design contribution. Designers have then moved from the periphery to the core of the organisation, designing its external manifestations of touchpoints, interaction channels and journeys, to considering the mechanisms supporting the delivery processes (relying on tools such as service blueprint, flow charts, etc.) (Junginger and Sangiorgi 2009). This movement required engaging with issues of organisational change and service implementation, which are still a matter of debate. Emphasis has been given to the need for designers to develop the ability to read and relate to organisations, as much as they are skilled in studying and interacting with users (Sangiorgi and Prendiville 2017). Here designers are exploring the potential of developing inquiry tools or "design conversation pieces" (Junginger 2015) to unveil pre-existing design practices and culture (see Fig. 7.3), as well as deeper structures and values at the basis of the client organisation (Lin et al. 2011). Few studies have documented the relevance of the nature of designer-client relationships in relation to the level and kind of change achieved in service systems and client organisations (Sangiorgi et al. 2015; Yu and Sangiorgi 2018).

The transformative potential of service design has also been addressed as transformation design, which "seeks to leave behind not only the shape of a new solution, but the tools, skills and organisational capacity for ongoing change" (Burns et al. 2006, p. 21). This focus on building capabilities for lasting change, has been particularly studied in relation to the transformational needs of public sector, exploring modes and strategies to embed and develop design capabilities (Bailey 2012) or to establish design-driven innovation labs within government (Kimbell 2015).

The transformative role of service design has also been acknowledged in service research and service science. In the recent past, the focus of service research has moved beyond individual satisfaction to collective and ecosystem well-being, while transformative service research has become a research priority (Ostrom et al. 2015).

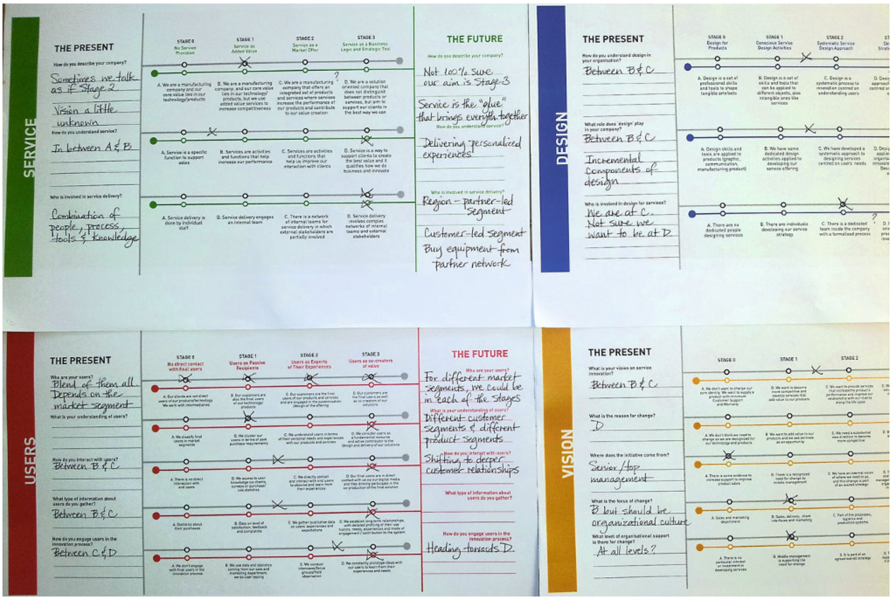


**Fig. 7.3** Example of conversation piece: tool for inquiry (source: Sangiorgi et al. 2016)

Transformative service research focuses on creating uplifting changes to improve the lives of individuals (customers and employees), families, communities, society, and the ecosystem (Anderson et al. 2013; Anderson and Ostrom 2015). In this context, service design can envision new service concepts and service systems to enable transformative value creation. This transformative value creation involves critical reflection of present situations and brings awareness of new possibilities; global changes of meaning that alter human relationships and explores new ground; going beyond hedonic value to more global and collective psychological well-being; and generates a virtuous trajectory towards individual and collective well-being (Blocker and Barrios 2015).

The potential of service design to conduct inquiry into organisations and support their transformation as well as their ability to guide new service systems implementation and change are still not well documented. Concerns are expressed that service design projects are mostly focusing on the initial exploratory stages of service innovation, while lacking the ability to guide the execution phases, where change actually happens (Grinevich 2015). However, recent studies have also found that instead of merely creating new services, service design prompts organisational logic transformation, with significant changes in the organisational mindset and routines towards service innovation (Kurtmollaiev et al. 2018).

This literature review has articulated the human-centred approach of service design to service innovation, while it has pointed toward the ongoing debate on how it can or should support multidisciplinary collaborations as well as inform transformational change. With the following section, we have studied the exemplar

practice of Logotel, an Italian service design agency, to gather evidence on how this is practically happening, and propose a more elaborated understanding of service design as a multidisciplinary and transformative approach.

## 7.4 A Case Study into the Human-Centred, Multidisciplinary and Transformative Practice of Service Design

Given this background on service design and its potential to address the call of Service Science for a human-centred, multidisciplinary and transformative approach to service system innovation, we considered case study research as an adequate approach to explore how these dimensions can manifest in practice. In particular, we aimed to extend the current understanding and proposal of service design as a human-centred, integrative and transformative practice, by exploring *how* and *why* the acknowledged and documented human centred and creative approach of service design (as a disciplinary field) could be adopted and adapted to support the integration of multidisciplinary knowledge during innovation and change processes. We were interested in formulating a 'working hypothesis' on service design (Cronbach 1975) to be applied for future research in Service Science as a human-centred field of research and practice.

To this end, we adopted an in-depth, single exploratory case study research approach. Case study research is considered as an adequate approach to address why and how research questions for the understanding of contemporary phenomena within their real context (Yin 2009). The case study we selected as a *critical case* of service design is Logotel, an Italian service design company active since 1993, with more than 160 people staff, 50 national and international clients and more than 70 on-going projects.

Logotel is a multifaceted service design company that since 1993 has been mixing strategy, training and operative support projects by adopting design as backbone approach to innovation. Logotel has been operating at an international level, from its first project abroad in Peru. The countries they have worked in include: Brazil and Chile (2000), Turkey and Greece (2001), Algeria (2002), China (2005), France and Spain (from 2013). They have offices in Paris and Madrid, with headquarters in Milan.

Given its unusual size (for a service design agency), the company developed a particular approach to design and to design management, which coordinates a mix of multidisciplinary teams with different skills and backgrounds. Their clients span from sport to luxury, automotive, beauty, healthcare, banking, insurance, tech, mobile service providers, energy, fashion and many more sectors.

They put considerable emphasis on the need to collaborate, which is at the basis of their exploratory work on the Weconomy (http://www.weconomy.it/book/) and their pay-off 'Making together'. Collaboration is a crucial factor to co-design and to involve all the actors that take part in the experience/process in a company. The necessity of collaboration springs also from the wide array of different sectors Logotel operates in. They do not specialize in a specific industry. This non-specialization has led Logotel to explore many new worlds, always involving their clients with their specific expertise in the creation process.

Every multidisciplinary team collaborates to the growth of the business thanks to solutions that combine, not only design strategy, but also education, to empower and motivate people to change. These solutions involve the business and the social community engaging people in the process of change in the long run. The symbiotic interaction among these core activities fuels the creation of value and innovation while shaping the final and integrated client experience. Finally, in order to implement and constantly update its design process, Logotel develops experimental projects that explore different areas, spanning from collaboration with artists to key actors involved in the cultural evolution of service design (Fig. 7.4).

The value of this case study for our original question lied in: (1) its success, documented by the fast growth and rare size for a service design agency (Sangiorgi et al. 2015) and the relevance of its portfolio; (2) the multidisciplinary team and approach guided by service design: "Business community, design, training: every project or solution is a mix of these ingredients with the tools of service design" (www.logotel.it); and (3) their focus on supporting clients toward service

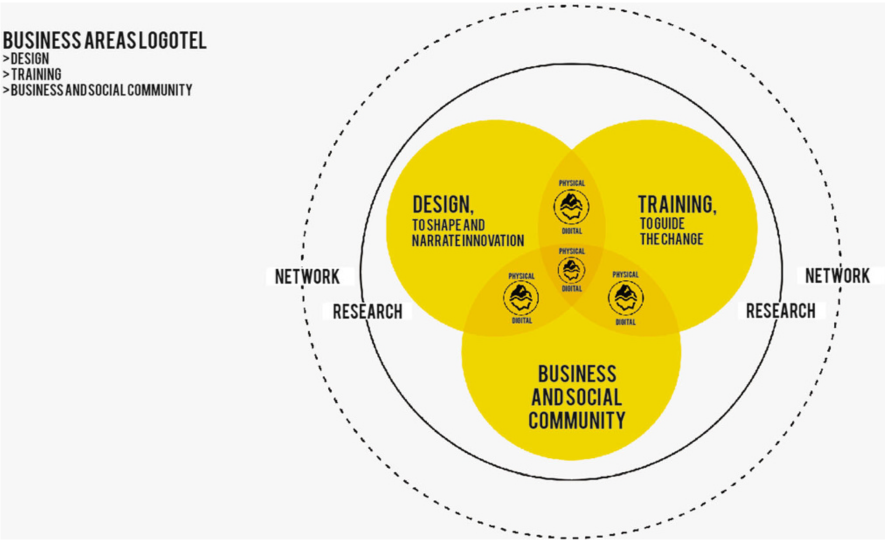


**Fig. 7.4** Organisational structure of Logotel that mirrors the blend of skills and expertise deriving from the worlds of Design, Training and online Business and Social Communities

implementation and business transformation: “people, ideas and tools to accompany the transformation of organisations” (www.logotel.it).

Our unit of analysis for this exploratory study has been the overall agency (*holistic case study research*), and not individual projects, as our interest was to understand how and why service design was chosen and applied as a core approach to innovation and service system transformation in Logotel, and not in its detailed application. We therefore privileged the understanding of both the evolution and approach of service design at the company and strategic level, engaging senior managers that helped linking the strategic dimension (why) with project management (how).

We therefore combined interviews—lasting between 32 and 68 min—with eight senior managers (see Table 7.1) from the three key areas of the organisation (business community, training and design) and the strategist of Logotel, with archival research, reviewing presentation materials from a selection of yearly kick off events that signed significant steps in the evolution of Logotel toward becoming a service design company (see Table 7.2).

The semi-structured interviews focused on the following topics: role and background of the interviewees; evolution of Logotel and of Design within the company;

**Table 7.1** Summary of interviews

| | Interviewee role | Description | Duration |
|---|---|---|---|
| **1** | Senior manager and coordinator of design | Co-managing the design area and managing complex projects. Managing people in the design area (around 25). | 60 min |
| **2** | Senior manager of training | Managing projects of the education area. | 58 min |
| **3** | Senior manager of business community | Co-managing the business community area. Co-managing people in the business community area (around 90). | 68 min[a] |
| **4** | Senior manager of business community | Co-managing the business community area. Co-managing people in the business community area (around 90). | |
| **5** | Senior manager of business community and digital innovation officer | Co-managing the business community area. Co-managing people in the business community area (around 90). Participation in the conceptualization of projects connected with digital environments. | 58 min |
| **6** | Human resource manager | Dealing with labour law and the training and development of people. | 49 min |
| **7** | Art director | Coordinating and managing designers, mentoring, delivering things. | 32 min |
| **8** | Senior manager of training | Coordinating the training area and managing projects in this area. Managing people in the training area. | 35 min |
| **9** | Strategist | Defining the growth strategic lines of Logotel. Head of the design area. Leading some projects. | 46 min |

[a]Interviewee 3 and 4, were interviewed in the same session of 68 min

**Table 7.2** Summary of archival research

| | Kick-off event | Description | Year |
|---|---|---|---|
| **1** | Instruments and Ideas | Strategy document, event support materials | 1993 |
| **2** | Weconomy | Internet website (http://www.weconomy.it), Weconomy Book | 2010 |
| **3** | Making Together and Service Design Company | Internet website (http://www.makingtogether.it), Manifesto, slides kick off meeting, training course slides | 2012 |
| **5** | Impact Organisation | Manifesto, slides kick off meeting, visualisation of new organisational structure, training course slides | 2017 |

types of consultancy projects; understanding of design, service and service design; mode of integration of multidisciplinary contributions; approach and dimensions of client and service system transformation.

### 7.4.1 Data Analysis

Interviews were transcribed and qualitatively analysed using the Nvivo software (Charmaz 2014). Data coding was divided in two phases: initial coding where code data fragments (e.g. segments of interviews) were identified, followed by a focused coding, integrating and synthesising initial codes into more meaningful categories.

In parallel, an archival research was performed, by reviewing presentation and training materials from a selection of yearly kick off events that signalled significant steps in the evolution of Logotel towards becoming a service design company. From this documentation review, it was also possible to gather information about core concepts, decisions and strategies behind their transformation.

From this analysis, the following set of themes emerged, gathering information about Logotel's background, practices and perspectives: (Co) Evolution of Logotel (and the market); diverse meanings of service(s) and design(ing); accompanying and partnering as core strategy; learning organisation and; learning by projects. The data analyses' outputs were all integrated, resulting in a holistic understanding of how and why Logotel puts in practice a human-centred approach to service design, integrating multidisciplinary knowledge and enabling transformation processes within its organisation.

## 7.5 Case Study Analysis

In the following sections, we report our insights on how Logotel has changed because of the growing complexity of the market, evolving service design to an overarching approach for their multidisciplinary projects; how service design has been developed as a horizontal skill across the departments, and how it has been used to accompany transformational projects with clients.

### 7.5.1 Service Design to Address the Complexity of the Market

One of the themes emerging from data analysis has been the relationship between the evolution of Logotel in terms of internal organisation, offering and types of projects on the one hand, and the parallel transformation of markets and society (see Table 7.3) on the other hand. This parallel evolution is described as a reaction of Logotel to a changing environment, but also as an intuition and proactive re-direction of the company to embryonic society, professional or market signals. The foundation of Logotel is for example associated with opportunities lying behind the abolition of market monopoly:

> *it was a beautiful and big idea, from Giuliano Favini, that he understood 25 years ago that monopolism, [...] for example telephony, ok? Energy, this monopoly or oligopoly was being destroyed [...] Giuliano understood 25 years ago that that world was finishing, ok? So he understood that it was important to train sales people, because you play easy if you are the only player* Senior manager of business community

Furthermore, the other two key units and competences of Logotel are described as following 'big ideas': the 'digital business communities' unit was developed in 2000 with the idea of merging training with the developing Internet and the concept of gamification, while service design was originally addressing the developing needs of retail design, therefore strongly focusing on the physical design of shops. This stage of Logotel is also associated with the payoff 'Instruments and Ideas', giving organisations the right tools and concepts to be more competitive in the market, and therefore focusing on 'what' clients can do.

Following this evolution, the company that initially provided training solutions for its clients, has gradually diversified its offerings to include the creation of digital business communities and the design of services. These broad offerings matched three functional departments that still exist in the company. Several interviewees reflect on how these departments were initially operating in a separated manner. For example:

> *We were 3 areas that could have been living in three different organisations, kept together by the vision of a family* Senior Manager of Training

> *At the beginning they were three very distinct centres [...] therefore as they were three products* Strategist

Consistent with this idea of detached business areas, the projects that Logotel developed were initially allocated to a particular department and focused on a single competence. This suggests an organisational model based on an autonomous functional *departmentation*, meaning that the organisation defines departments in terms of functions, and those departments behave in an (almost) autonomous way, having a significant control over the project and the required competences to develop it (specialisation).

This initial configuration then gradually started to change, leading to a stronger connection and collaboration among departments and disciplinary fields. This seemed to be motivated by an increased complexity of developing projects, which were reflecting the transforming demands of organisations. Interviewees have

**Table 7.3** Stages of the evolution of Logotel

| Stage | Payoff | Internal organisation | Types of projects | Market demand |
|---|---|---|---|---|
| What | Instruments and Ideas | Functional departmentation: separate training, business community and design units.<br>Three key offerings: Training, Business Community and Service Design. | Specialized and simple projects, requiring the contribution of a major unit and its competence. | Abolition of monopoly in telecom, energy sectors.<br>Development of the role of sales departments in organisations<br>Relevance of retail design<br>Emergence of Internet |
| How | Making together Logotel as a Service Design company | Combined approach:<br>– Functional departmentation: separate training, business community and design units.<br>– Temporary product departmentation: temporary combination of training, business community and design units. | Coexistence of both specialised and multidisciplinary projects:<br>– Specialized simple or complicated projects, requiring the contribution of a major unit and its competence.<br>– Complex projects, requiring the contribution of several units and competences. | Need to manage multiple channels<br>Focus on Soft dimensions (e.g. customer experience)<br>Need to become customer centric<br>Need for deep organisational transformation |
| Why | Impact Organisation | Project base multidisciplinary teams; Increasing number of transversal competences and functions. | Coexistence of both specialised and multidisciplinary projects:<br>– Specialized simple or complicated projects, requiring the contribution of a major unit and its competence.<br>– Complex projects, requiring the contribution of several units and competences.<br>– Complex systems projects requiring the contribution of several units and competences and other external partners/consultancies. | Design as a commodity and the need to differentiate<br>Market fluidity and resistance to change of large scale organisations |

suggested for example that recently clients have been dealing with a new set of challenges that include: companies have limited resources available to invest so they focus more on software (e.g. experience, branding) rather than hardware (e.g. retail shops); they need to improve internal communications beyond organisational silos;

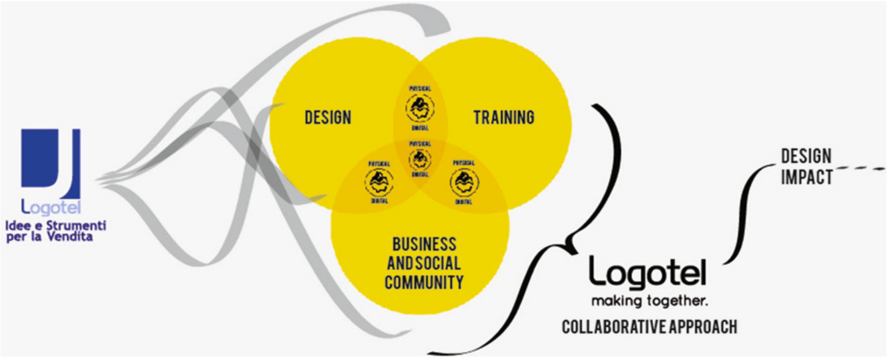


**Fig. 7.5** Visualisation of the key stages of Logotel evolution

they need to learn how to operate across multiple channels; they have developed Customer Relationship Management systems, but they want to make the most of data; they need to become more customer centred (Fig. 7.5).

The transformation of markets therefore required organisations to change, orienting their needs more on HOW to change and innovate: "*this is the stage of 'how', 'how we make it', no? through multidisciplinary competences that mix in, and therefore the projects have started to be the fusion of these three areas*" Strategist.

This requirement to accompany organisations in significant change projects, brought the attention on the need to closely collaborate with organisations, which is at the basis of the new payoff 'making together', meaning engaging people in understanding and building together the process of change:

> *give them, to give you the know-why, before the know-how. So why you have to change, why you have to go here, why why why… so you can be much more involved in the process, and making together is our pay-off, you know, 'Logotel. Making together' which is you, with me and the team, and your team, and so on* Senior Manager of Training

Projects gradually evolved from being just simple (like a 2-day course) to become more complicated (like a training process with different stages) to become complex (like an organisational change project); complex projects are described as "*bringing together different phases, pieces, intelligences, ways of working, at times with objectives that are unclear to the client, and this from a project point of view. From an organisational point of view, they bring together wider teams of people, exigencies to plan, different competences to be applied*" Senior Manager of Training.

Although these projects require the contributions of several departments at Logotel, the ownership of these projects is still attributed in terms of functional areas, even if at the project level the interactions are increasing and if training initiatives are developed to encourage collaboration:

> *the three areas remain separate in terms of functional and hierarchical reporting, but they then merge under a project. So let's say that the real [organisational] unit then where we act is the one of the project* Senior Manager of Training

Finally, Logotel is now starting a third stage of evolution, that is qualified by the focus on WHY, meaning the importance of being able to measure and testify the actual impact they are able to generate for the client organisations and beyond. This has expanded their approach, adding the stage ‘life’ to the ones of ‘design’ and ‘delivery’. In a context where everyone is able to generate ideas, the challenge has become the one to demonstrate the ability to choose the good ideas, implement them and prove positive impact in the life of people. This third stage launched in January 2017, has been described with the pay-off ‘Impact organisation,’ and is initiating a further internal organisational and cultural transformation where more competences are becoming transversal functions (e.g. data analysts), and a dedicated impact evaluation approach is developing and being tested. This evolution is also aligned with the growing complexity of projects where clients are asking to set up complete new businesses, that often requires multiple consultancies collaborations.

This evolution of Logotel is what has gradually motivated the proposal and development of service design as an integrating practice beyond its disciplinary area, as discussed in the next section.

### 7.5.2 *Service Design as an Overarching Human-Centred Approach*

When discussing this evolution of Logotel, one of the consequent transformation that now qualifies it, has been the centrality given to Design, not as a disciplinary field (one of the three core areas of Logotel), but more as “a way of doing things”, an “approach”, a “method”, a “concept” that has created a common “language” across the company.

> *Before, design was just a piece, the methodologies were used just by that piece. From a certain moment, I don’t remember when, but many years ago, Logotel wanted to transfer this approach to all projects that we do, so even when you manage a training course, also when you design a business community, meaning whatever we do this approach from service design has been gradually transferred to all people and to all projects* Senior Manager and Design Coordinator

This centrality and understanding of Design, reflects an evolution of the perception and understanding of design in general by client organisations, moving from a creative and specialised discipline (e.g. product designers or architects) to a more methods and process focused approach (see also Design Thinking), which has attracted considerable attention.

> *Before, design was… was considered more as a creative, just a creative discipline, that was developed in Italy by architects or people who were near to creative fields, not such a very strong and method-based discipline.* Art Director

Design is described as the “driver” of multidisciplinary collaboration, based on **key elements and principles** that have been gradually shared across the Logotel three

units. These qualities strongly anchor the innovation process to people, qualifying the design approach for its human-centeredness:

1. *Starting from people and experiences*: Design is always centred on people (both staff and users) and their experience; any project Logotel develops is now considering all the key moments of the user and staff experience—pre, during and post service provision—in all their details and touchpoints;

   *Start from people in the moment that there is a project, start from their needs, their expectations, design all the projects in all their phases, in all their moments* Senior Manager and Design Coordinator

2. *Flexible and unspecialised*: Design is not about tools, as it is a way of approaching challenges, that can be and should be reinvented all the time not to become a trend or a specialism; Design is also about designing the project itself considering the specific situation of the client;

   *my doubts that I had on the classical design, service design, more or less I think that are confirmed, I mean that, I think that's not a solution, it's just a way for doing something but each time you have to consider and consider why you are doing what you are doing, and so rebuilding our tools, if needed.* Senior Manager and Digital Innovation Officer

   *So, the strength of design is not being specialised, and so working then with more specialised people, but its strength is that of regenerating itself every time* Strategist

3. *Giving shape to things*: Design is described also as the ability to make things tangible and visual to support communication, collaboration and supporting decision making and doing; it is about giving shape to all the key stages of the project;

   *in the moment we have a piece of paper in front, an image, a map, something, so a shape which is also concrete, it is easier to share a perimeter and a language, it is easier to bind oneself to something, images and therefore say 'ah no, for me it is like this, not like this!' And so accompanying the project, living it step by step with them, and arrive to something that is shared by both. So, Design in the building of the project and giving shape to all the different phases.* Senior Manager and Design Coordinator

4. *Ability to engage people*: fundamental part of designing is described also as the ability to stimulate and facilitate engagement of people during and after the project development, to be sure people accept and participate in the implementation and management of the new solution;

   *why people should do what they ask them to do, the engagement, how to engage people, in my opinion is the key [...] we are designers and think for human being, so, even if they are service or they are products or they are content we should always think on that, so in my opinion, and also it's one of the lessons that Logotel learned from the training, when you train people if you want to raise their attention you have to exchange value with them, and continually, every 5 seconds, to convince them that the energy that they are spending with you is worthy* Senior Manager and Digital Innovation Officer

Combined with this understanding of Design, there is also a specific understanding of what a 'service' is and what does it mean in the work of Logotel. Service is described in different but interrelated ways: it is the service produced for the client helping them to implement the change and achieve their aims; it is everything that generates benefit and utility for people, a continuous co-creation of value that requires careful design; it is a model of relationship among people, a story that needs to be created and sustained.

1. *Service to the client:* Logotel emphasises the importance of providing a long term service for client organisations, which means to 'accompany' the organisation not only in the design, but also in the implementation journey; this journey requires to engage all staff and any stakeholder involved and affected by the new venture, motivating and training people, creating the required capabilities and tools as well as the physical parts of the solution;

   *we don't only design the way to get there, providing the idea and the concept, but we care to make it happen and accompany it along the time, and so offer a more continuous service [...] So the accompaniment, therefore a continuous service, means that it does not end with the design part, but we train people, we help people, we see how it develops, we understand if something is not working so we need to revisit it* Senior Manager and Design Coordinator

2. *Service as benefit and value creation:* service here is intended as everything that can benefit and be useful to whoever will use the solution; something that creates value to all the stakeholders involved, and an exchange of value that is in a constant transformation as situations and needs evolve and change;

   *I mean it's something, in my opinion, that brings value to all the stakeholders, not only to the one that's buying or... but a right exchange of value [...] It's when you can build something that works during the time, that keeps an exchanging of value, you are building good services.* Senior manager Business Community and Digital Innovation Officer

3. *Service as a relationship:* service is conceived also as a relationship between people, no matter if providers or users, that can be nurtured and sustained as a story.

   *Service is a relationship and we are therefore very expert in people, and this is a culture that Logotel has had for 20 years. The relationship is absolutely between who, in brackets, supplies the service and who uses it, but at the same time roles can invert, who uses the service today is also a service producer, so it is really a relationship between people. It is a story that we build among people. And so in this I feel, I mean, strongly enough that we have a people-focused positioning which is very strong* Strategist

Combining these two dimensions of Design and Service helps defining how and why Logotel describes itself as a people-centred service design company. It is a choice affected by the evolution of market and design themselves, but it is also a way to crystallise a specific approach to innovation and change. Logotel aims to apply this people and experience centred, flexible, visual, practical and engaging approach to all its projects, to create everything as a service; this means to design everything

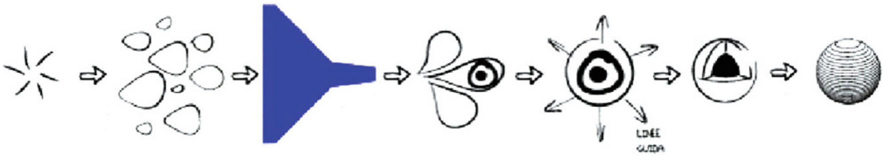

**Fig. 7.6** Sketch of Logotel integrative and multidisciplinary service design process as detailed in Fig. 7.7

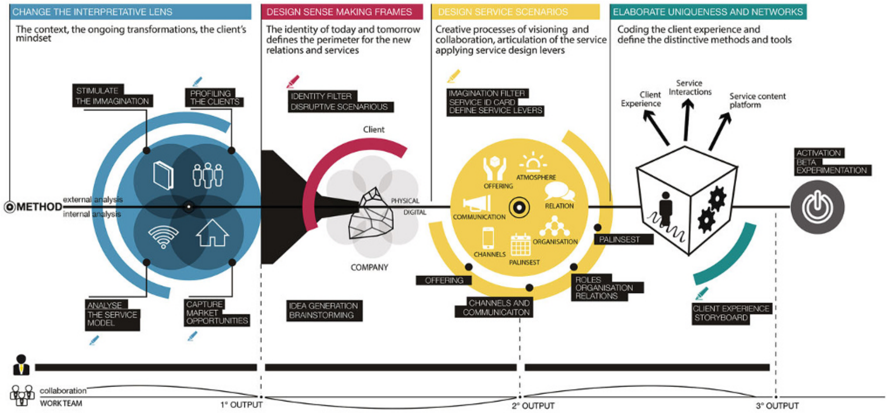


**Fig. 7.7** The four-steps ‘funnel’ method: Decision, Design, Delivery, Development

with the aim of creating value for their client organisation as well as among them and their customers and other key stakeholders, paying attention to each individual encounter and detail and to the quality of these relationships. At the heart of this approach there is the choice to accompany the organisation and service development “from strategy to delivery”, and lately to “life”:

> *everything is necessary, not only to design the concept of something, but also to bring it to reality thanks to training, thanks to preparing people that are within an organisation or that are in contact with clients in their stores, to adopt the new approach, the new concept, the new idea; whatever is the project that we are going to do, we then accompany it along the time, maybe with a spirit, a more digital service, in a way that it can be fed, from a palimpsest, contents, by continuous updating* Senior Manager and Design Coordinator

The importance of accompanying people in these transformations reflects the complexity of service systems, which are human-centred; for this reason, the innovation approach needs to be focused on training, engaging and aligning people with the aimed for change (see Figs. 7.6 and 7.7).

### 7.5.3 Learning Service Design as Horizontal Skill

The evolution of Logotel suggests the ambition to work increasingly around complex and multidisciplinary projects, where service design works as the 'backbone' for their work. Fusing and integrating the three areas of Logotel has not been immediate and it is described as a work in progress that started from a conscious choice of orienting Logotel to become and present itself as a service design company.

This integration of knowledge has been favoured by consolidating this common approach, language and identity around service design; the internal change process has been facilitated sharing core concepts during internal events (see Fig. 7.8), or formally training people and engaging them in a reflexive and project-based learning by doing process, where professionals work in groups, integrating skills according to the needs of complex projects.

Logotel's approach is based on organising people in collaborative cross-functional teams, facilitating an integration of competences according to the needs of each project. Logotel professionals may follow specific techniques (e.g. storyboard, service blueprint) that support their practice, but they also adapt their work according to the needs of the project, even inventing new tools/approaches (*ad-hoc* approach). Within this context, there are two strategies to integrate skills and facilitate collaboration between employees within Logotel. Firstly, through internal training: e.g. once a week, employees are invited to discuss what they have been learning and which are the good work practices. This enables an exchange of formal knowledge.

> *we stay with our colleagues for 90 minutes, and in this moment we share what we have learnt in this year, we talk about contents and good practices, ok? And this is an internal project of training.* Senior manager of business community

Secondly, during daily work: people work together, sharing doubts or curiosities. Here there is also an exchange of tacit knowledge, which is the 'learning by doing'. Mixing people in specific projects is part of the strategy of Logotel to enhance the ability of people to work in a multidisciplinary way. Thirdly, Logotel emphasizes the


**Fig. 7.8** Kick-off event for the launch of the new Logotel pay-off 'Impact Organisation'

role of more formal and informal social events that enable the sharing of a developing identity of the organisation.

> *there is a lot of informal exchange in Logotel, because we don't believe in education, but in curiosity, so it works in Logotel. Oh, what are you doing? I'm writing this, I'm studying Pirelli (...) Oh, can you tell me something? Oh, it's good, can I learn something, can you tell me*. Senior manager of business community

Finally, Logotel Design is presented as an approach able to integrate multidisciplinary knowledge, by supporting a common language and methodology, helping to involve customers during the project process. Service design supports the integration of knowledge, by enabling a formal approach to be followed, which helps to motivate customers to follow a design process.

> *design gives us a method (...) we try to design our method, because our customer now is very curious, is educated, (...) and now we must convince him, and service design helps us in this kind of moment. So, service design can help you (...) to sustain your idea with a method*. Senior manager of business community

Reinforcing this ability to work in a multidisciplinary way, is the combination of specialists and T-shaped professionals; interviewees identify T-shaped professionals as the facilitators of knowledge exchange and integration within the company.

> *I have people who know ... who had very well developed vertical expertise, and I have people who have a preponderance (...) that is, they have a T, the long part made of design, training and NCBs, and then, however, have developed the horizontal part of the T with not only soft skills related to collaboration, but also related to (...) design that allows you to design and carry out projects with a systemic vision different from if you work only with vertical expertise, and if the competence to move them is hard and not soft.* Senior manager of training

This process toward favouring the integration of competences led by an overarching service design approach is what strongly qualifies Logotel as an agency; it is though described as an ongoing and evolving process given also the constant evolution and adaptation of their approach to innovation.

### *7.5.4 Service Design as Accompanying and Partnering for Transformation*

Companies arrive to Logotel with various demands that reflect the changing needs of markets: the need to work in a more collaborative way ("we work in silos"), to make the most of their CRM systems ("They have not designed really which is the experience they want to offer"), to develop their multichannel strategy, or to help them implement and engage people in a change process that might come from a renewed brand identity or strategy. All of these projects start with a period of scoping where Logotel explores what the client really needs, but also what the client is ready to listen to and change.

> *So from the first reflections, from a first analysis, from a first comprehension, done the interviews, done the scouting in the shops, but for our internal use only, so therefore not yet with very structured activities, we start a period that can last also 6 months, it can last between one to six months of getting closer [...] Meaning that we start from a need and then slowly we start to suggest what a process could be, and making n or more checks, depending on how complex is the project, and how much the client is ready and able to listen to changes; he arrives for a website and we say 'listen maybe your problem is not a website, you should do this and that with people'; so based on n situations we arrive to design what we think is a methodological proposal* Design Coordinator

Organisations are described as 'organisms' that are very different from each other ("*every company is... I compare it to an organism, it is a metabolism on which you need to understand how... which are the resistances to change*" Strategist); it is suggested as fundamental to understand the organisation to value how to approach and relate with them, what are their resistances, to lead them toward more systemic and important changes. In some cases, this is done with a 'top down' approach when senior managers are highly committed to the need of change and Logotel then helps to engage staff and key stakeholders in this transformation process; in other cases, Logotel talks about a 'pirate approach', where projects and small changes are used as vehicles for longer and bigger transformations. The project becomes the locus to start building up new rules and practices.

> *the project as the perimeter of the intervention, because the project enables us to isolate, to build new rules of engagement, of the game [...] the project becomes the opportunity to redesign the working models, so while they do the project in reality it is like they are going to a gym, they are training, no? And while they are practicing they are actually learning. And so, they then bring along what they are leaning on the other... other realities* Strategist

To support this transformation, Logotel repeatedly underlines their conscious choice to create and maintain a close relationship with their clients, to "accompany" them along the implementation and service development journey; animating this relationship, often working mostly within the client organisation, requires a "collaborative" and "flexible" approach, that constantly adjusts depending on the level of engagement and alignment of the client organisation and of their key partners with the ongoing project vision and aim.

> *Collaboration, and, with the collaboration, flexibility, and with focusing on the mission of the project, and on their real needs* Senior Manager and Digital Innovation Officer

When describing a particularly complex project with Diesel, this process of adjustment and engagement is particularly evident; this collaboration started with the request to organise a very technical course on the topic of 'conversion rate' to the stores and it ended up with a project involving 2000 people in seven countries around the world to redesign what they called their 'learning system', revisiting the roles, competences and individual development paths.

In some cases, Logotel supports key decision-making moments and processes, providing the materials and the support to win over the eventual resistances or better align intent and resources.

> *you have moments where you help, in particular if there are important things, maybe our contact in the organisation does not have the decisional power, to put him in the conditions to sell the project in the organisation, because the other complexity is that maybe we talk with people from the CIA, or from marketing, or from sales, but maybe for budgets beyond a certain amount, they need obviously to convince and widen* Design Coordinator

These transformation and implementation processes, act on several dimensions of the organisations, such as skills and competences (e.g. in the sale department), the working style (e.g. to become more collaborative), the relationship with clients (e.g. be able to listen to customers), the embodiment of a new brand identity, the data management (e.g. digitalisation of information); often the transformation is described as a necessary change of mind-set and attitude that is better able to cope with contemporary markets and society demands, and that can make the most of Logotel contribution.

> *They have to change their mind-sets, and their working habits, because if you are... until you are in the tunnel of... work flows that are the same, or have remained the same in the last 40 years, you keep doing the same... you keep doing ever same things, ok? You don't give yourself the challenge, the chance to experiment, to find new ways, new solutions, but this is a very difficult objective to gain, because it implies an organisational mind-set change, so until companies are structured in the ways they were structured in the '60s or in the '70s* Art Director

The willingness and strategies adopted to accompany client organisations along this transformation journey further qualifies the service design approach that Logotel has developed.

## 7.6 Discussion

We started this chapter with the Service Science quest for an innovation approach able to address the human-centeredness of complex service systems, to integrate multidisciplinary contributions and support service system change. We have suggested that service design, recognised already for its human-centeredness, could bring a contribution to this demand, by leveraging its potential of supporting the integration of multidisciplinary knowledge and enabling change in services and organisations. Our question has been therefore *how* the human-centred service design approach could be applied and expanded to integrate multi-disciplinary teams instilling change and transformation in complex service systems.

This case study has been taking a close look at a large consultancy, that has gone through a transformation itself toward the convergence and integration of knowledge and expertise to enhance service innovation in client organisations, as required by the growing complexity of service system innovation projects.

Our study has shed some light to a till now mostly theoretical proposal of service design as a multidisciplinary practice and as a strategy to approach a more complex and evolving markets. Logotel, as a service design company, documents this clear distinction between an understanding of *service design as a design discipline* (one of their three disciplinary areas), embedding other related skills such as interaction design, web design, communication design, or interior design, and *service design as*

*an integrative and multidisciplinary approach* that informs a more human centred and creative approach to service system innovation. We suggest that this distinction is still not clear both within the service design research community, still focused mostly only on what designers do, as well as within the Service Research and Service Science, that seem to struggle to value what designers and a design approach can bring to service system innovation.

What emerges from the case study, is that service design has become in Logotel an overarching approach, thanks to an operation of *simplification and distillation of some guiding concepts, principles, methods and key innovation stages*; these key qualities have been disseminated through various strategies, including informal and formal training, project-based learning and the cultivation of a specific cultural environment. Likewise, the case study illustrates how the 'design knowledge and expertise' seemed to add to the horizontal skills (e.g. communication and interactional expertise) that a T-shaped professional needs to develop to be able to effectively collaborate in service system innovation. This design horizontal skill and expertise—summarised in its people and experience centred, flexible, visual, practical and engaging approach—is learned and developed during complex and multidisciplinary projects, mainly following a learning by doing mode. *The cultivation of this design horizontal skill seems to become the key driver for the convergence and integration of multidisciplinary knowledge during service system innovation.*

Finally, peculiar of this large consultancy and novel—considering the existing offering across service design agencies—has been the interpretation of the concept of Service. Service is described not as a given market offering or output, but as a dynamic condition of value exchange and co-creation, that is not still but constantly evolving, and therefore in need of a constant adaptation and negotiation. Design solutions—as the example of the 'learning system' developed for Diesel—act as complex human centred service systems that are constantly developing and reconfiguring. This dynamic view of service, manifesting in the interactions and relationships among people, is at the basis of the investment of Logotel in providing client organisations with a 'continuous service' accompanying them from strategy to delivery and beyond. Here lies the actual transformative dimension of service design, which goes beyond what the service design literature has documented so far. A human-centred (or people centred) approach, does not end in transferring and translating user's need into service solutions, but into supporting organisations and in particular people within and outside organisations to engage and contribute to the transformational process to implement, adapt and evolve that same solution with organisations. This approach and willingness of supporting organisations along this transformation journey is described as not always economically rewarding, requiring dedicated people to work along organisations for long periods of time; it does also need a strong evidence of impact to justify a continuous investment in the collaboration with Logotel. This justifies the very recent orientation of the agency toward better documenting impact and focusing on the WHY of their work. In this description, we can then suggest that *service design is becoming less about designing new service solutions, and more about designing transformative processes that enable the collaborative co-creation of value; a continuing, collaborative and flexible*

*approach that constantly adjusts depending on the level of engagement and alignment of the key partners and the need to nurture the evolving dynamics of value co-creation for service system transformation.*

These propositions are an initial contribution to the challenge Service Science is facing, given the increasing complexity and human-centeredness of service systems. We here propose how service design as a human centred, integrative and multidisciplinary approach, can provide the new knowledge needed at the intersection space between disciplines for service innovation (Medina-Borja 2015); *design knowledge can become a transversal area of study and practice* to explore better ways and strategies to leverage multidisciplinary contributions to service system innovation. Also cultivating the *design horizontal skill* complements the debate about the need for service scientists to be T-shaped professionals (Sphorer and Kwan 2009). Finally, this case study contributes to the emerging area of investigation that is trying to link institutional theory to service innovation and design. As learned from the case of Logotel, service design work can inform discussions around the embedded agency paradox, mostly by highlighting *a distributed and collaborative approach to changing institutions*. This approach brings together actors who might have the power and mechanisms to change institutions, but might in some cases lack the vision, motivation and capacity (i.e. client organisations), and adjacent actors in the service systems who have the interest and vision to change institutions, but do not have the necessary power to break them by themselves (i.e. design agencies) (Garud, Hardy, and Maguire 2007). *The accompanying work of service design to organisational and system change can be a focus of study for collaborative dynamics of institutional change processes.*

## 7.7 Conclusions

This chapter discusses the potential and the challenges of service design practice, to contribute to the call of Service Science for a human-centred, multidisciplinary and transformational approach to service system innovation. Our case study provides a preliminary overview of how this is manifesting in practice in an innovative large Italian service design agency that has been forced in the last years to transform itself to better address the growing complexity and fluidity of society and markets. The adopted formula and interpretation of service design, mirrors the complexity and fluidity of the conditions where their clients operate, transforming the innovation approach in a dynamic, ever going practice of probing, interpreting, challenging, training, making things happen and measuring to accompany organisations in the transformation they need.

Following a tendency of Service Science to highlight the importance of people within service systems (e.g. Human-Centred Service Systems), service design brings a pragmatic contribution to the field by providing a mind-set, methods and tools that put in practice a human-centred approach to understanding and designing service systems. This contribution has a dual dimension, in which service designers engage

in understanding people and their contexts as sources for innovation, as well as when they involve stakeholders during design and transformational processes.

In order to effectively understand and design for complex human-centred service systems, a service design approach supports professionals to integrate multidisciplinary knowledge in practice. This integration, as illustrated in Logotel's case, is facilitated by the consolidation of a common approach, language and organisational culture around the practice of service design. Likewise, it is favoured by an internal transformation process, supported by the sharing of common concepts during internal events, by formal training of employees and by a project-based approach, where people and their skills are allocated according to projects' needs. Besides, multidisciplinary collaboration is also facilitated by the work combination of specialists and T-shape professionals, where the latter are recognized as facilitators of knowledge exchange and integration within the company.

In this sense, the service design practice can be seen as a practical means to integrate multidisciplinary knowledge, to engage people along transformation processes within and across organisations, and implement a human-centred approach to service system innovation; an approach that focuses closely on how to enable and maintain positive value co-creation dynamics and interactions among people at different service system levels.

As future developments, we foresee the enhancement of interdisciplinary research in Service Science in order to enable innovative solutions to a wider variety of challenges at different levels of service systems. In particular, this chapter has explored service design as a multidisciplinary approach for innovation that brings a human-centred and transformative practice to Service Science. This understanding could be furthered advanced through research on the use of service design in multidisciplinary teams, to better understand and assess which are the best practices, tools and strategies that facilitate collaboration and integration of different resources to support service innovation processes. Likewise, studies on horizontal design skills that boost collaboration within and between organisations could deepen the comprehension of which competences future service scientists must learn to foster practical approaches to transform service systems.

In the academic level, more investments in interdisciplinary programs are needed to stimulate the collaboration and the training of T-shaped researchers. This is the case, for example, of Service Design for Innovation,[1] a Marie Curie European Training Network, established to stimulate research in service design to foster service innovation. This network has brought together multidisciplinary researchers and professionals from six universities and two large European organisations to develop a research training program in this domain, covering industries such as utilities, health care and information technology.

We would also expect further research efforts on Service Science directed towards a deeper understanding of business and service system transformation processes. The growing interest in the integration of service design capabilities in

[1]For more information, access: http://www.servicedesignforinnovation.eu

non-design oriented organisations to change existent service innovation approaches might provide the right conditions to empirically explore transformation processes. More specifically, this situation might allow researchers to investigate how service design is contributing to the transformation of organisations from within (new practices and principles), and how service design is supporting transformational change in complex service systems that go beyond the boundary of the firm.

Finally, Transformative Service Research, is a priority for Service Science and Service Research. Service design transformative potential should therefore be explored to leapfrog Transformative Service Research, and create the uplifting changes to improve the lives at the individual organisational and societal level (Anderson et al. 2013).

**Acknowledgements** This work has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 642116.

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# Chapter 8
# Emerging Design Research Themes: A Research Review from Design, Service, and Management Studies

**Yuriko Sawatani**

**Abstract** The targets of design have moved from industrial goods to services against the backdrop of service economy, complicated system problems, and the development of information technology. In recent years, research on the relationship between design and management has drawn attention in service design. Elucidation of the influence of service design on organizational strategy and management, such as how service design is involved in organizational change and how to manage relationships with stakeholders is under way. Changes in design targets also affect design methods and evaluation indicators. However, as design studies are being done across many different fields, it is difficult to see the full picture. In this chapter, I review research focusing on design, service, and management research, and organize how research areas relate to design, with an eye toward future research topics.

**Keywords** Service design · Innovation management · Entrepreneurship · Service system

## 8.1 Introduction

The targets of design have changed from goods to services given the backdrop of the modern service economy, increasingly complex systems, and the development and use of information technology (Hobday et al. 2012; Löbler and Lusch 2014; Sawatani 2014). Design research has moved from interface design to interaction design, in which user interfaces and user experiences are considered together in a comprehensive design approach (Candi 2007). In addition, research on interactions in services now focuses not only on end-users but also on other stakeholders and

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_8

includes organizational design (Hyvärinen et al. 2015). Furthermore, in the context of service science, research has expanded to include service systems and service life cycles as well (Ceschin and Gaziulusoy 2016).

Nowadays, design and consulting firms often provide service-design services, promoting service-design practices with companies, government, NPOs and other organizations. For example, in the UK, the Design Council has expanded to include service design; and the UK government's digital transformation (Gov.UK 2018) has been taken up as a precedent case of service design utilization. Service design can also be effective in improving healthcare and health and welfare services (Green et al. 2016). Research on the relationship between design and management has also drawn attention in service design (Amit and Zott 2001). Elucidation of the influence of service design on organizational strategy and management, such as how service design is involved in organizational change and how to manage relationships with stakeholders, is also underway (Hyvärinen et al. 2015).

Changes in design targets also affect design methods and evaluation metrics. For this reason, research on design now occurs in many fields, including design, service and management studies (Hyvärinen et al. 2015; Wry and York 2017; Baek et al. 2015; Yu and Sangiorgi 2018; Sawatani 2014). As the scope of design studies has increased across fields, it is becoming more difficult to see the overall picture of service design. It is time to weave the many threads together to get an overall view of the field. In this chapter, first I survey literature within design research, service research, and management research to discuss how these areas that impact service design have changed over time. Second, to grasp the overall picture of design research, I investigate the transition and relationships of the three fields. Finally, I discuss some future research topics.

## 8.2 Research Method

This chapter surveys literature on design research across several fields to begin to draw a picture of the state of service design and the influence of various design disciplines on service. Because design targets extend beyond industrial products to services, and organizational and social systems, papers were extracted from design studies and also from management and service studies. Thus, representative journals were selected from design, service, and management areas. In the design area, Design Studies which is the top journal in design area and The Design Journal which covers a wide range of design topics were selected. In the service area, *Journal of Service Research*, which is centered on service marketing research, and *Service Science*, which is a journal of service science research, were selected. In the management area, *Academy of Management Learning & Education* and *Strategic Management Journal*, which are thought to be developing relatively new fields, with the *Academy of Management Journal* and *Academy of Management Review*, which deal with a wide field, were selected. Design research in management study will be emerging, and not established yet, so four journals with various perspectives are selected.

**Table 8.1** Potential articles identified from journals (2000–2017)

| Journal | Articles with "Service Design" in Title, Abstract, or Keywords | Articles with "Service Innovation in Title, Abstract, or Keywords | Articles with "Entrepreneurship" in Title, Abstract, or Keywords | Total |
|---|---|---|---|---|
| *Design Studies* | 11 | 6 | 4 | 15 |
| *The Design Journal* | 10 | 7 | 1 | 10 |
| *Journal of Service Research* | 27 | 26 | 3 | 37 |
| *Service Science* | 10 | 16 | 2 | 26 |
| *Academy of Management Journal* | | | 24 | 24 |
| *Academy of Management Review* | | | 23 | 23 |
| *Academy of Management Learning & Education* | 1 | 1 | 32 | 32 |
| *Strategic Management Journal* | 1 | 2 | 18 | 21 |
| Totals | 60 | 58 | 107 | 188 |

All articles in these journals from 2000 to 2017 whose title, abstract, or keyword contained "service design", "service innovation", or "entrepreneurship" are searched. First two keywords, "service design" and "service innovation" are used for the initial research paper search. However, only a few management research papers are found. Entrepreneurship study in management study could include a study creating a new business and a service system, so the third keyword, "entrepreneurship" is added. A total of 188 articles were found (see Table 8.1). 13.3% of the articles with the search terms came from design journals. By using "service design" keyword, 61.7% articles come from service journals. Out of 188 articles, 37 articles, 19.7% include duplicated keywords.

Abstracts of all selected articles are investigated and grouped into key categories, such as design and methods, community, service system, social innovation, etc.... Design and service journals share common categories, such as design and methods and communication. Recently the community study is emerging. On the other hand, articles from management journals are grouped to entrepreneurship and education and traditional research topics, such as company. After 2006, social innovation is growing. Interestingly service system and organizational research areas consist from design, service and management studies.

## 8.3 Research Review from Design, Service, and Management Perspectives

In design studies, various sorts of research on the significance and role of design and on evaluation of the design process and outcomes have been conducted (Candi 2007; Dong et al. 2016; Nelson and Stolterman 2012). Design targets extend from products to product service systems (PSS) and service innovation (Dewberry 2013; Ceschin and Gaziulusoy 2016). Service design methods, such as empathy and ethnography, are being developed (Wikinson and De Angeli 2014; Stacey and Tether 2015; Prendiville 2015).

In recent years, design targets have expanded even further, for instance, to the design of a community with no boundaries (Baek et al. 2015; Morelli 2015), including design of public services and sustainable systems. Design may play a role not only in design of new systems and redesign of technologies and existing systems from a human-centered viewpoint (Hyvärinen et al. 2015), but also in transforming systems and continuous social value creation (Ceschin and Gaziulusoy 2016). To realize such broad goals, current methods are not enough.

Regarding service studies in particular, *Service Science* and *Journal of Service Research* are investigated. The former is targeted at service systems, and research focused on use of information technology, such as big data and simulation (Migueis and Novoa 2017) and service innovation (Sawatani and Fujigaki 2014; Siltaloppi et al. 2016; Jonas et al. 2016), especially those affected by information technologies (Löbler and Lusch 2014). In addition, many articles discus design issues from service system viewpoints, such as healthcare system and PSS. By contrast, the *Journal of Service Research* has service marketing as its main subject, and research on customer service interaction and the designer's role in service operation design, management strategy, utilization of information technologies (Bhappu and Schultze 2006) and service innovation (Yu and Sangiorgi 2018) were main points of discussion.

Research on new business creation and human resource development/education, including business startups has been done in business administration using network analysis (Vissa and Chacar 2009). In research on innovation, research on business models (Amit and Zott 2001) and social innovation (Wry and York 2017; Peredo and Chrisman 2006) is often done in collaboration with customers and employees.

With the development of information technology, firm boundaries may become ambiguous (Webb et al. 2009; Santos and Eisenhardt 2009; Argyres et al. 2015), and research expands from competition theory, focusing on enterprises, to ecosystems of value co-creation (Peredo and Chrisman 2006). In addition to considering economic value within an enterprise, the mechanism of value creation of an open social system (Calas et al. 2009) is also attracting attention.

## 8.4 Emerging Design Research Themes

To understand better this landscape of research on design, three categories are selected for the further investigation. The service system category is a foundation of design, service and management studies. The other two categories, such as community and social innovation, are emerging areas. Design and service studies focus on community design, for example, a public service. On the other hand, social innovation is studied in management research, as expanding the company's boundary and giving impacts to society. To clarify relationships among these studies, these three categories are organized into nine topics (see Table 8.2). Relatively established research categories such as service design methodology in design and service studies and entrepreneurship in management study (e.g., Candi 2007; Dewberry 2013; Prendiville 2015) were excluded for the further research.

In the area of service systems, management study treats a company as a service system, but service and design studies look at the dynamic structure of service innovation. The business model (Amit and Zott 2001) extends the business boundary (Webb et al. 2009; Santos and Eisenhardt 2009; Argyres et al. 2015) and urge managers to focus on an ecosystem around a company. Now a company is one of elements in a service system. Considering economic value is not enough, but also social values (Calas et al. 2009) around the company need to be considered as a key. In service and design research, technology adaptation, especially information technology, to the business (Bhappu and Schultze 2006; Löbler and Lusch 2014) are

**Table 8.2** Key categories and topics for research on service design, service innovation, and entrepreneurship

| Category | Topic | Discipline | Representative articles |
|---|---|---|---|
| Service System | Business Models | Management | Amit and Zott (2001) |
| | Business Boundaries | | Webb et al. (2009), Santos and Eisenhardt (2009), Argyres et al. (2015) |
| | Business and Social value | | Calas et al. (2009) |
| | Source of Service Innovation (Technologies) | Service | Bhappu and Schultze (2006), Löbler and Lusch (2014) |
| | Source of Service Innovation (People, Organization) | Design and Service | Sawatani and Fujigaki (2014), Siltaloppi et al. (2016), Jonas et al. (2016), Yu and Sangiorgi (2018) |
| Community | Community Design | Design | Baek et al. (2015), Morelli (2015) |
| | Organization Transformation | | Smets et al. (2012), Hyvärinen et al. (2015), Baek et al. (2018) |
| | Community Transformation | Design, Service | Blocker and Barrios (2015), Ceschin and Gaziulusoy (2016) |
| Social Innovation | Social Enterprise | Management | Peredo and Chrisman (2006), Wry and York (2017) |

important areas. Recently, not only considering technologies as source of service innovation, but various actors such as designers and organizational change, are argued (Sawatani and Fujigaki 2014; Siltaloppi et al. 2016; Jonas et al. 2016; Yu and Sangiorgi 2018).

The key contributors of service innovation are expanded from research and development (Sawatani and Fujigaki 2014), which has been a key player of product innovation, to designers (Yu and Sangiorgi 2018) and stakeholders belonging to multiple organizations (Jonas et al. 2016). These various actors including users are creating a new service system together. As an example of business transformation in manufacturing resulting from a focus on service, research and development personnel may be responsible not only for technology development but also for design in creating new service systems for value co-creation with customers (Sawatani and Fujigaki 2014). In this way, it may also be necessary to embed new knowledge in existing organizations and existing management systems through service innovation (Smets 2012; Hyvärinen et al. 2015; Baek et al. 2018).

Yu and Sangiorgi (2018) compared the service design process with New Service Development (NSD): In traditional service development, design, development and implementation phases are focused internally, whereas in NSD, especially when the design function is outsourced, a new service system may be developed, with focus on embedding the system in the customer's organization and on maintaining it.

Siltaloppi et al. (2016) discussed institutional design in the service ecosystem of actors, whereas previous studies discussed mainly relationships between enterprises and their outsourcers who are responsible for their design and innovation functions. Each organization that the actor belongs to has its own institutions. When creating a new service system with multiple actors, a new framework with institutional groups of those organizations as toolkits is created. These are deeply related to community design.

In community design, traditional service design methods have been applied to public services and the like (Baek et al. 2015, 2018; Morelli 2015; Hyvärinen et al. 2015; Blocker and Barrios 2015; Ceschin and Gaziulusoy 2016), though current methods have some limitations. Hyvärinen et al. (2015) and Baek et al. (2018) mentioned that when designing communities of multiple organizations, it is assumed that transformation of existing organizations will be required. Ceschin and Gaziulusoy (2016) discuss creation of transformative value through recombination of new resources in the community, with social value itself embedded in the community.

Studies of traditional companies that are closed systems and that emphasize economic value, and community practices aimed at maintaining social value by implementing community problem solving, have a common language in the term "service system" (or "service ecosystem", which emphasizes more dynamic aspects). Service design is the foundation for linking enterprise systems and community systems to each other, transforming the organization from one to another, and designing new service systems.

In this way, the research topics of design, service, management research have been expanded based on (a) service system or service ecosystem, (b) community

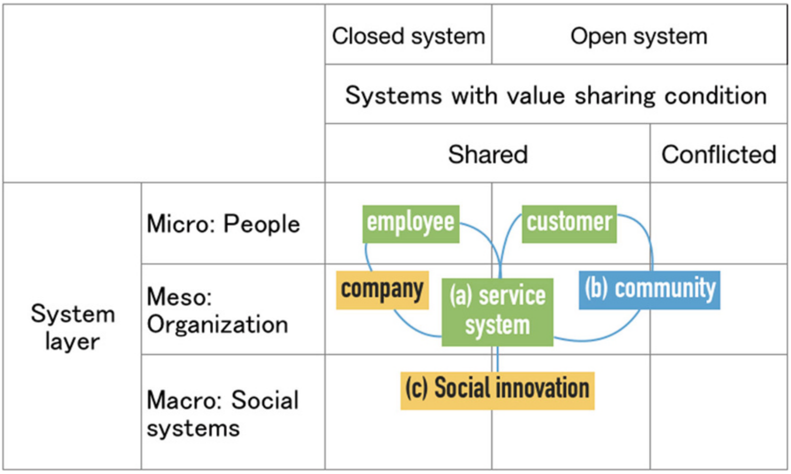


**Fig. 8.1** Emerging design research themes mapped to service system types (Sawatani 2014)

design, and (c) social innovation and transformation, such as organizational transformation or institutional transformation. This is illustrated in Fig. 8.1.

## 8.5 Conclusion and Discussions

In this chapter, I have reviewed some threads of contemporary research focusing on design in service and management research, and I have attempted to organize how these research areas are related to design. Service systems, including service ecosystems, will continue to frame interesting research areas, especially community design, which as an open system, requires multiple stakeholders. In addition, social innovation, which comprises traditional innovation as a special case, and which focuses on economic value creation, will be an important area to study. In these research areas, service systems are dynamic and transformed continuously. To sustain a service system, transformation is necessary, as is the study of transformation. As discussed, further collaboration in research in design, service, management will only become more important in the future.

In management studies, research has expanded from closed systems that emphasize economic value for enterprises to service systems that include customers, partners, and various stakeholders. It is an inside-out viewpoint that analyzes the service system by looking out from the enterprise, considering economic value inside of it. By contrast, in design studies, subjects of design have expanded from product to service, community, and society based on design, and especially engineering in applying technology into systems through a human centered design approach. In other words, it is an outside-in viewpoint that focuses on social value

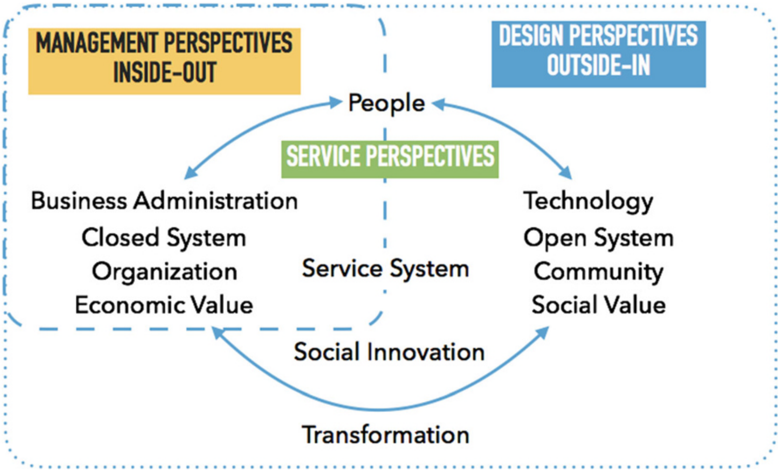


**Fig. 8.2** Disciplinary perspectives and design research themes

in the newly created service system from human centered design perspective. Integration of these perspectives on service systems will be an interesting area of study in the future (see Fig. 8.2.).

Social enterprise research aims to create not only economic value but also social value (Peredo and Chrisman 2006; Wry and York 2017). Wry and York (2017) presented a framework for creating social innovation for social welfare by linking the identity of organizations (role) and individuals (personal). Social innovation projects and activities aimed at Creating Shared Value (CSV) are underway in many companies that use designers (e.g., NEC 2018). However, most of these projects are tested in isolation from the original businesses of the companies, and it is rare that results are directly incorporated into existing businesses. For the value created by the personal identity of designers embedded in existing organizations, further research on the organizational design of the company and the business model design are required.

By reconstructing the various management theories based on Service-Dominant Logic (Vargo and Lusch 2004) in service studies and by understanding service as a service system (as advocated by service science, Maglio et al. 2010) and further as a service ecosystem (Vargo and Lusch 2016), collaboration across design, service, and management studies is expected to contribute to the design of communities and the design of institutions.

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# Chapter 9
# High-Tech vs. High Touch Service Design in Healthcare: A Case for Considering the Emotional Biorhythm of the Patient in Technology Interventions

**Alexis Strong and Rohit Verma**

**Abstract** The advent of Value Based Care (VBC) in the U.S. healthcare system has changed reimbursement models and shifted the paradigm of healthcare. Financial incentives not only reward clinical quality and outcomes, but they put more power in the hands of the patient and more emphasis on patient-centric care delivery models. To that end, service science has an increasingly respected seat at the table in the healthcare industry.

One of the predominant debates in healthcare service delivery today is how we will use health information technology (HIT) to improve access to and quality of care, as well as the patient experience. This chapter focuses on the latter—the patient experience. With specific attention given to patient-facing digital and mobile health tools, this chapter examines the literature on patient attitudes toward HIT and identifies a key gap in the research, namely that we have yet to apply core service design principles to the application of technology in healthcare. We argue the case for future research that examines (1) the unique emotional load of healthcare and thus the need to better understand the emotional biorhythm of a patient journey for effective HIT support, (2) the application of service science frameworks that can help account for essential characteristics such as the impact of time across a patient journey and the complexity and severity of the need within it and (3) the potential need to redefine success metrics given this patient-centric, service science perspective.

**Keywords** E-health · Health care service · Patient experience · Emotion · Service design · Operations management · Healthcare consumerism · Value-based care · Health information technology

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_9

## 9.1 Introduction

In the wake of the Affordable Care Act (ACA), the healthcare industry is experiencing a paradigm shift that incentivizes providers to put the patient at the center of the care delivery model. New yet sometimes opaque payment incentives are slowly shifting the power from a paternalistic dynamic in healthcare to a consumer-centric one. In addition, influential organizations like the Institute for Healthcare Improvement (IHI) have established constructs such as the Triple Aim (patient experience, population health, and per capita cost) that provides a frame work for improved health system performance with this new paradigm in mind.

Providers, therefore, are rapidly trying to adjust to a new environment in which they are managing larger patient panels due to expanded insurance coverage in the wake of ACA with higher expectations of service established by other, more mature service industries all while trying to drive down costs. This shift in the industry is driving a new look at service design in healthcare and a strong push toward the use of eHealth and digital technologies to improve patient experience and achieve scale at lower costs.

Over the last decade, academic research has begun to investigate the role of digital technology in healthcare, however, the majority of the research focuses on patient engagement strategies and digital tools for general patient education. Thus far, there has not been much research on the role of digital technology in healthcare from the perspective of the patient, in other words, their attitudes, perceptions, or desire for digital solutions at a given point in their journey. Most existing research on patient perceptions is in the context of adoption and utilization of a tool that has been developed in a silo and not as an element of the overall experience.

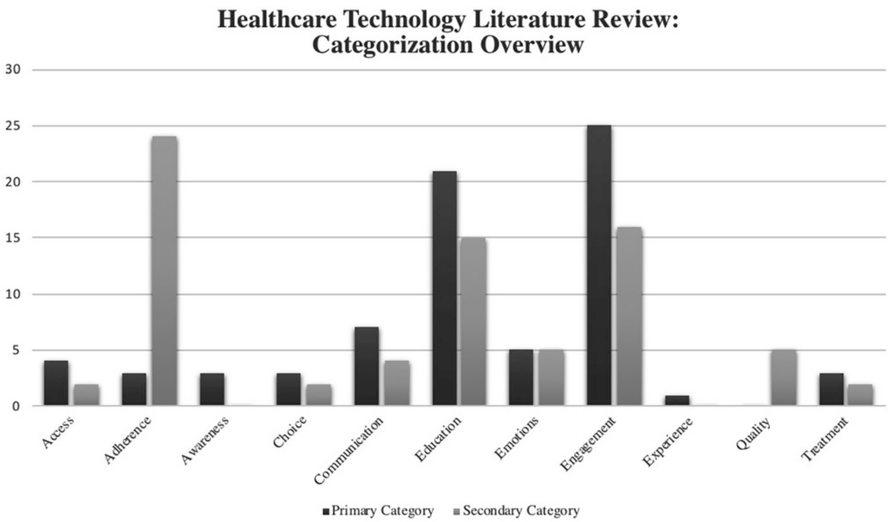
Given that the healthcare industry carries a unique risk profile and emotional load for the consumer (McColl-Kennedy et al. 2017), relationships and communication in general carry more weight (Weiner and Biondich 2006). Information exchanges in healthcare directly affect a human being's intrinsic need for safety (Maslow 1943) and therefore are often entangled in fight or flight responses and a patient's ability to interpret and understand their care plan. Therefore, the use of the appropriate channel of communication has the potential to directly aid in or detract from the patient's clinical outcome and experience of care.

The intent of this chapter is to explore the research that has been conducted on the patient's perspective of the role of technology in healthcare and how this research informs the foundational service design frameworks. The convergence of research on eHealth and digital tools with service design frameworks that consider time, complexity, and emotional elements of the experience will aid in shifting the paradigm. In identifying future research opportunities, the aim is to lead us to a more precise use of patient-facing technology in healthcare, such that its presence, absence, or functionality in a given moment is strategic and outcomes metrics demonstrate its ability to improve scalability, improve outcomes, and/or enhance experience.

### 9.1.1 Literature Review: Patient Attitudes Toward Technology

In a PubMed search between 2010 and 2017 using the following MeSH terms ("Patient Preference"[Mesh] OR "Attitude to Computers"[Mesh]) AND "Computer Communication Networks/utilization"[Mesh], 108 articles were returned. Given the Table 9.1 inclusion and exclusion criteria and the Fig. 9.1 flow diagram, 29 articles were included in the literature review.

Of the 29 papers that were included in the literature review, none considered the role of technology across the patient journey. In other words, despite some strong research that explores patient motivations for engagement and adoption, there is a lack of research exploring the role of technology in the broader context of healthcare service design and across a dynamic and emotional patient journey.




As seen in the above graph, the most common perspectives on technology explore engagement with and adoption of the tools, their use for education, or a patient's adherence to the tool and subsequent behavior change as a result. Most of these discussions revolved around patients' general information gathering needs, chronic disease management, or support for the elderly. There was no conversation about whether patients would want tech support or human support at high versus low stress points or how these tools would adjust to support patients as they weave through inpatient and outpatient encounters or from one episode of care to another.

The intention of this research was to look at the broader context of a patient journey to understand what we know about opportunities to support patients through technology across the entire experience of care. That said, it is important to note the intentional omission of provider-facing technology and telemedicine research in the literature review. Telemedicine is the only MeSH term within the "Health Care Delivery Systems" parent category in PubMed that is related to technology, an indication that it was a "first mover" in the care delivery HIT research space, but

**Table 9.1** Inclusion and exclusion criteria used for the screening process

| | |
|---|---|
| *Inclusion criteria* | |
| Study type | Publication date from January 1, 2010 to December 31, 2017 |
| | Studies from any geographical area |
| | English language |
| | Journal articles |
| Participant type | Adult (>18 years) patients |
| Type of digital health tool | Any patient-facing digital health tool or channel (web, mobile, portal, etc.) |
| Setting | Any primary, secondary, or tertiary care setting |
| *Exclusion criteria* | |
| Study type | Published pre-2010 |
| | Non-English language |
| | Grey literature/not published in a peer reviewed journal |
| | Dissertation/thesis |
| | Published abstracts or conference proceedings |
| | Commentary or review articles, personal stories or case studies |
| | Impact of digital engagement on disease state |
| | Digital use as indicator of patient behavior or disease risk |
| Participant type | Non-patients (staff, clinicians, etc.) |

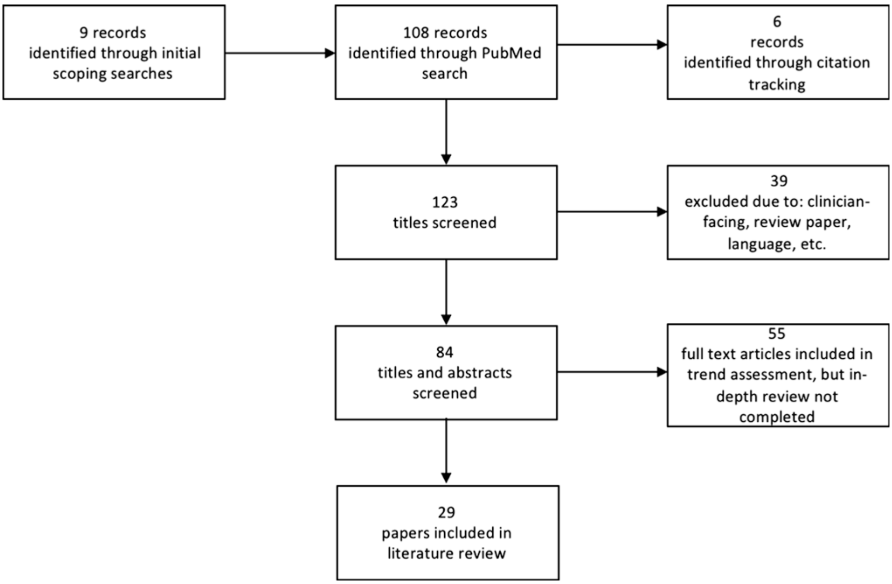



**Fig. 9.1** Flow diagram of patient perceptions of health technology literature review search strategy

also an indication that it is one, specific application of a tool for a designated point of care solution. Therefore, despite it having been well-researched, we omitted telemedicine from the review in favor of a more high-level, long term perspective on the patient experience across the continuum of care.

As it relates to service science, it is worth noting the interesting development, in recent years, of more advanced concepts around segmentation within the HIT adoption and engagement literature. Exploration of patient motivations, decision-making, and behavior change has resulted in research on adoption indicators such as health literacy levels (Mackert et al. 2016), patient attitudes and values (O'Leary et al. 2015), and "person-based" approaches that consider the psychosocial context of users and the patient's experience of digital interventions as a complement to the "well-known 'theory-based' and 'evidence-based' approaches to incorporating behavioral science into intervention development." (Yardley et al. 2015). However, research has yet to establish alignment on which of these indicators is truly correlated to adoption and the only agreement seems to be that higher adoption occurs with patients who have higher technology adoption in general (e-patients) (De Rosis and Barsanti 2016).

This movement toward more sophisticated segmentation is indicative of a shift toward patient-centric HIT research. While this is progress and forward movement in the space, this literature review indicated that we have yet to see the HIT question fully layered on top of service science research that looks at consumer behavior in the context of a journey with dynamic motivators and decision criteria. The case for applying these frameworks was made by Berry and Bendapudi (2007) when they brought attention to the fact that healthcare exhibits several foundational characteristics of service industries in that it is intangible, heterogeneous, perishable and inseparable, however, it is unique in that it is fraught with negative emotions—reluctance, confusion, stress and anxiety, not to mention the physical feeling of being ill. Berry and Bendapudi argued that the similarities provide solid ground for the application of service science to healthcare despite the need to keep its unique differences in mind. We argue that the unique differences in healthcare—namely its high emotional load—is even more reason to lean on service science. The best service operators are not merely service delivery experts, but experience designers. They not only offer a transactional service, but they curate an emotional experience and no one needs that more than patients.

Furthermore, service science and related fields such as social and behavioral sciences understand the importance of context. As was stated by Christensen et al. (2017), "What largely drives [the motivation to avoid the complications or symptoms of the disease by adhering to a prescribed therapy] is the intensity and immediacy with which patients feel the complications." Stated another way, Dubé et al. (1996), found that emotional load differs based on the novelty and severity of the disease and symptoms. In other words, a patient's engagement with their care at any given point, including their adoption of digital health tools to manage their own health and co-create the ideal outcome, has a lot to do with context and the resulting stress and anxiety they are experiencing. Therefore, a successful digital strategy in healthcare has to account for both the emotional biorhythm of the patient across the continuum of care and the unique context within which they are operating.

### 9.1.2 Healthcare: Breaking Down the Emotional Biorhythm

"Understanding patient emotions is often a critical success factor in the outcome of healthcare. Not only are emotions widely regarded as a primary influence on human motivation in general, but the experience of hospitalization is a highly emotional event for most people" (Dubé et al. 1996). Neurobiology research adds another layer to that stating that when the brain goes into a state of high stress, the body has physiological and behavioral responses that impact the hippocampus, hypothalamus, amygdala, and areas of the prefrontal cortex which impair our cardiovascular and immune systems as well as our ability to manage our emotions and impulsivity, process information and make decisions (Flier et al. 1998; McEwen 2007; McEwen and Gianaros 2010) When we bear in mind the importance of emotions and stress in healing and understand that healthcare in itself is confusing and technology in general induces stress and anxiety (Mick and Fournier 1998), we realize that we must build technology solutions that are designed around the emotional biorhythm of the patient journey.

This argument often meets resistance because there is a perceived complexity in an operations approach that hinges on emotions which are nebulous and intangible. Fortunately, hospitality and the service sector have long-since studied the interplay of service design and emotions. "Experiences are inherently emotional and personal; many factors are beyond the control of management such as personal interpretation of a situation based on cultural background, prior experience, mood, sensation seeking personality traits, and many other factors. Nevertheless, within management's domain, the service designer can design for experience and operations manager can facilitate an environment for experience by manipulating key elements" (Pullman and Gross 2004). In other words, it may be difficult to manage the entirety of the emotional biorhythm, but there are certain aspects that are well within the control of the provider and stress-inducing elements that occur at a regular cadence in the patient journey that can be mitigated.

Two critical factors that influence a patients' emotions and perceptions of their experience are the elements of time and complexity—or "novelty" and "severity" as Dubé defined it. "With respect to the clinical moderators of patient emotions, no significant differences emerged across medical diagnoses. However, the novelty of the medical diagnosis and the severity of health problems, as measured by the level of nursing care needed or as perceived by the patient, exerted a significant influence on some aspects of the emotional experience" (Dubé et al. 1996). The novelty of a disease is a function of time and therefore, as has been documented in the patient engagement literature, emotional state as it relates to the novelty of a disease will be dramatically different at the "beginning" of a patient's experience than at the "end" (Graffigna et al. 2015). Complexity or severity of the disease will also fluctuate. Depending on the disease type, patient co-morbidities, disease progression etc. the severity may fluctuate in terms of symptoms, sense of urgency, fear and anxiety. Therefore, we know that the elements of time and complexity—whether it be proximity to diagnosis, perceived proximity to mortality, duration of the illness

and symptoms, or experience more broadly including personal context—are key drivers of emotions in healthcare. Each patient has a unique journey but having an understanding of these factors allows us to design for commonalities in the biorhythm with enough flexibility for exceptions which means being strategic about high-tech or high-touch interventions where they will best serve the patient.

Although Dubé found that medical diagnosis had no significant difference on emotions, we would argue that there are some exceptions. One such exception might be sexually transmitted illnesses (STIs) or other diagnoses that are often associated with shame, guilt, or embarrassment. As stated by Bergozzi et al. (1999), in non-healthcare settings, shame and embarrassment have "led to particular coping responses: the greater the shame and embarrassment, the greater the impulse to hide, to withdraw, and to avoid contact with [others]". In such scenarios, patients' desires for anonymity and privacy might drive a service design that is more heavily digital. This is further evidence that an understanding of the emotional biorhythm of the patient can breed innovative technology-infused care delivery solutions.

Aside from being highly emotional, healthcare journeys are highly personal. Psychosocial profiles and belief systems, triggering events, context and complexity, as well as elements of time can all contribute to a unique journey. However, as service industries have come to realize, if we can determine the right attributes for healthcare segments, there is likely to be a fundamental cadence to journey that will allow us to design emotionally aligned experiences for better co-production of outcomes.

### *9.1.3 Service Design: A Critical Perspective for Healthcare*

Recently, research on technology interventions in healthcare has focused more on the need to design for patient motivations, their personal life and values (O'Connor et al. 2016) and the human psychological dimensions, namely behavioral, cognitive, and emotional components of engagement (Barello et al. 2016). However, there is a lack of research layering those engagement strategies across the two critical components of service design mentioned above—time and complexity. Dubé's articulation of "novelty" and severity" are aspects of these characteristics as perceived by the patient in relationship to their disease, but the broader terms are constructs of service science that, when applied to the patient journey in healthcare, open a world of service science tools that can drive the Triple Aim.

In order to consider the application of service science to healthcare, however, we must first accept a fundamental assumption that the moral code of healthcare is not "equal care," but the "right care." Personalization and customization have always been fundamental to service design. They allow for better, more efficient service that serves both consumer and provider. In healthcare, however, the principle of segmentation has been resisted on moral grounds. That orthodoxy must be broken. Mass-customization from the likes of Amazon and iPhone has introduced consumers to the notion of co-creating curated experiences that are tailored to their needs. Experiences are different because they are curated with targeted information and

therefore they are more approachable, more engaging, and more valuable—characteristics we need in healthcare if we are to co-produce better outcomes with patients. If we accept the fundamental assumption that we are delivering "the right care for the right patient at the right time via the right channel," service design research has a lot to offer.

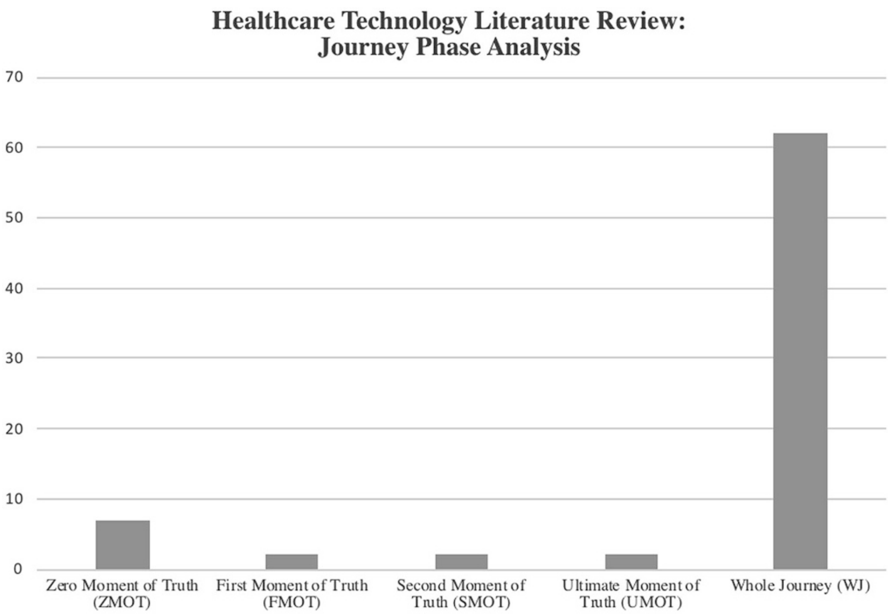
Given the "right quality" assumption, upstream ideas such as the service concept (Goldstein et al. 2002) will help healthcare organizations focus on who they are serving, what that means for their organization's identity, and how they are going to develop a strategy to meet the needs of their patient population, including the extent to which they want and need digital support. All too often, healthcare organizations provide the same care to all patients based on a commitment to a narrow interpretation of the "healthcare as a right" principle. However, so much of patient experience and engagement is a result of perception and "One reason for poorly perceived service is the mismatch between what the organization intends to provide (its strategic intent) and what its customers may require or expect (customer needs)" (Goldstein et al. 2002). A clear service concept will align decisions across strategic, operational, and service encounter levels, including health technology decisions given the patient population being served, their channel preferences, technology literacy, and other health engagement behaviors.

Tools such as the service quality model (Parasuraman et al. 1985) can then help healthcare providers reconcile patient expectations with operations, understanding that patient expectations and perceptions of care are all critical to their overall sense of service quality. The inclusion of an expectation management framework for healthcare service design means that the health system has the opportunity to think strategically about how they want to "train" their patients to co-produce the experience. As an example, The Ritz-Carlton Hotel Company employed "lobby lions," or greeters at the entrance, who would not only provide a warm welcome, but who would walk the guest to the elevators or to their room while reciting the amenities the hotel had to offer, their relative locations, and operating hours. This helped the guest feel informed while also allowing them the autonomy to customize their experience as needed. Healthcare and hospitals are more complex, overwhelming and anxiety ridden than hotels and yet we never "onboard" patients. Whether that "onboarding" relates to wayfinding through the physical hospital, engaging in processes like billing and payment, or using HIT applications like mobile applications or the patient portal, it would benefit healthcare companies to process engineer an experience in which both expectation setting and patient "training" are incorporated into the service design.

By far the most valuable tool in the execution of "the right quality" of care delivery via the right channel is the customer journey map. The journey map, with which most are familiar, was born out of the concept of service blueprinting (Shostack 1983), an approach that was aimed at combating the trend that "No one systematically quantifies the process or devises tests to ensure that the service is complete, rational, and fulfills the original objective...What piecemeal quality controls exist address only part of the service." Customer journey mapping took blueprinting to the next level in the era of the experience economy in the late 1990s (Pine and Gilmore 1999). The customer became the product (Pine and Gilmore

1999) and human-centered design firms such as IDEO started mapping service operations with the consumer at the center of the service design. The benefit of journey mapping was that it began to explore not only the role of customer emotions, but emotions over time.

In a 2016 article in the Journal of Decision Systems, McCarthy et al. (2016) went so far as to propose an integrated healthcare patient journey map that not only includes the physical, emotional, and "device" journeys, but that also includes the other two legs of the healthcare operations trifecta: quality and safety. This version of a customer journey map demonstrates the flexibility of the tool, but also the ability to build on it and revise it as an organization, industry, market and delivery channel change over time.




Furthermore, journey mapping and related concepts like customer lifecycle management allow for the consideration of critical healthcare experience dimensions like time, complexity, and emotions. At any given point in a patient's journey, they are trying to solve a problem. In the words of Christensen et al. (2017) "Jobs arise in [patients'] lives that they need to do, and they hire products or services to do these jobs." This framework, known as the "jobs-to-be-done" framework, allows for a consumer-centric perspective on what products, services, and tools providers need to offer at any given point in a journey in order to meet the needs of the patient. More importantly, however, when that framework is layered on top of a journey map, we get insight into the time, complexity, and emotions that surround that need in order to deliver both the *what* or type service solution and—equally important—the *how* or the delivery method.

### *9.1.4 Future Research*

The application of service principles to healthcare is not a new concept. Academics have increasingly broached the topic in recent years and service tools such as journey maps have started to make their way into payors, providers, and the pharmaceutical industry. However, few have taken a step back to consider how the foundational characteristics of the healthcare industry and its key differentiators impact the assumptions of those models as they are applied to healthcare. While healthcare is a service industry, it is unique in a few critical ways that can reveal a new landscape for research.

First, the emotional biorhythm of the patient is still not well understood. Legal and regulatory barriers to research in the healthcare industry in general coupled with challenges in studying patients, who are considered an "at-risk" population, results in healthcare research that suffers from a lack of falsifiability. In the case of research on patient emotions, however, there is the added complexity of opaque and subjective measurement tools. That said, new technology and research using tools such as electrodermal activity (EDA) (Kim and Fesenmaier 2015) poses promising opportunities to capture objective, real-time indicators of stress response, which, if mapped to observational data around events, interactions, and decisions across the journey could prove insightful for the future of healthcare service design.

As a follow-on to research on the emotional biorhythm of the patient there is an opportunity to align emotions to patients' "jobs-to-be-done" to understand how the interaction between a patient's emotional state and the complexity of the issue at hand might inform service design. In a paper on stress response and coping strategies, Carver and Scheier quoted Folkman and Lazarus in stating,

> Embedded in the Ways of Coping scale is a distinction between two general types of coping. The first, termed *problem-focused coping*, is aimed at problem solving or doing something to alter the source of the stress. The second, termed *emotional-focused coping*, is aimed at reducing or managing the emotional distress that is associated with (or cued by) the situation. Although most stressors elicit both types of coping, problem-focused coping tends to predominate when people feel that something constructive can be done, whereas emotional-focused coping tends to predominate when people feel that the stressor is something that must be endured." (Carver et al. 1989)

The interplay between the patient's need and the contextual emotion around that need could greatly inform the high-tech vs. high-touch debate and lead to a more strategic application of technology instead of "simply digitiz[ing] paper-based workflows" (Jones et al. 2012). The result would be a more engaged patient population and a more cost-effective, scalable healthcare system.

As we begin to focus on healthcare's key differentiators and understand the emotional biorhythm of the patient and the jobs-to-be-done, we also start to unpack the success metrics that correlate to that new paradigm. The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey scores and their associated financial incentives certainly spurred a movement toward patient-centric care, but as we get more sophisticated in our experience design approach we need to upgrade our metrics for success. The service industry has long-since supported

customer engagement as a superior metric to customer satisfaction. As Gallup stated in its 2014 State of the American Consumer Report, "Consumer engagement—which Gallup describes as a customer's emotional or psychological attachment to a brand, product, or company—is the definitive predictor of business growth." It is a metric that hinges on building trust, pride, and belonging with a service provider—emotions that are foundational to a relationship instead of a transaction and a paradigm shift that should also impact the way we design and implement technology solutions.

To that end, the progression of the healthcare industry from patient-centered care to relationship-centered care (RCC), or a care delivery system in which "physicians and patients work together in pursuing shared goals in health care, with attention to both illness and personal experiences" (Weiner and Biondich 2006) means we need a new paradigm for technology's role in relationship-building. Service frameworks such as the "Pyramid Model," (Parasuraman and Grewal 2000) which added technology to the "Triangle Model" (Kotler 1994) to provide a way of thinking about what technology is required to support company-customer interactions, customer-employee interactions, and employee-company interactions should be applied to healthcare to determine the appropriateness of the framework and how technology can facilitate the development of trusting relationships as a healing modality.

As we develop a more intimate and comprehensive understanding of the patient journey, a more robust understanding of health consumer segmentation should be developed. We have a crude understanding of demographic segmentation, but with the developments in behavioral science and advanced methodologies such as discrete choice modeling, we should be able to segment health consumers according to both marketing and operating segments (Frei and Morriss 2012) to drive access, engagement, and outcomes.

The final area of valuable future research is an examination of those critical healthcare attributes of time and complexity. We have seen evidence that novelty and severity of a disease impact a patient's emotional state, but there are many facets of time that can impact the patient experience—everything from the body of literature on patient wait times to attitude based on perceived mortality. Complexity in healthcare could be the level of care required, as Dubé et al. posited, or it could the "taxonomy of burden," meaning the context of an illness or the total work of being a patient—both inside the hospital and in the context of their personal lives (Tran et al. 2015). Without a thorough understanding of these attributes and how they impact the emotional biorhythm of the patient, we fail to understand how to serve the patient—where there are stressors that we can alleviate through service or technology to aid in their healing.

## 9.2 Conclusion

Healthcare in the United States is ripe for innovation. Government policy changes as a result of ACA inspired a healthcare consumerism movement that cannot be undone. However, the gap between consumer expectations and care delivery models

is so wide that current research such as this chapter's proposal to apply a service science lens to healthcare and HIT applications is only "shoring up the dam." We have a long way to go.

And yet, society moves on. Advanced technologies such as artificial intelligence (AI) and blockchain will soon infiltrate healthcare through startups and disruptors and the landscape will be forever changed again. That said, the power of an approach to healthcare that is anchored in service science is that it is human-centric. Healthcare fundamentally needs relationships as a healing modality and while technological advances may be able to cure more patients and even facilitate those relationships, they will never replace the ability of human connection to heal.

As we navigate the future of healthcare and the right balance between "tech" and "touch," both technology architects and service scientists should bear in mind their opportunity to drive change. Each has a unique skill set that is desperately needed in healthcare and yet, one that has not been fully realized. We continue to operate in siloes—creating point solutions without context or technology applications without the process engineering to facilitate patient engagement and adoption. Without consideration for the human element and good service design, we will never fully realize the benefits of HIT. Service science and technology need each other. Healthcare is counting on it.

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# Chapter 10
# Customer Experience Analytics: Dynamic Customer-Centric Model

**Mohamed Zaki and Andy Neely**

**Abstract** Creating a strong customer experience is a strategic priority for organizations. Companies are leveraging new technologies such as mobile applications, social media platforms, virtual reality, drones and the Internet of Things to provide smart services and enable a seamless customer experience. The complexity of using these technologies within an organization's myriad touchpoints has led to a data explosion across touchpoints in the entire customer journey (Lemon and Verhoef, J Market 80:1–62, 2016). Most of this customer data is unstructured textual data, which is generated at several touchpoints in the customer journey (McColl-Kennedy et al., J Serv Market 29:430–435, 2015). Text-mining techniques relating to traditional sentiment have focused on developing more accurate models but failed to obtain managerial insights by adopting these methods (Fenn and LeHong 2012).

Thus, firms require new data-driven methods that could highlight what really matters in driving customer satisfaction and delivering actionable insights (Lemon, GfK MIR 8:44–49, 2016; Hartmann et al., Int J Oper Prod Manag 36:1382–1406, 2016). In this chapter, first, we propose systematic multi-methods using a text-mining approach to capture and analyze customers' data. This is done to enable firms to identify critical pain points from real-time data and provide deeper insights into critical touchpoints in order to reduce friction and improve the customer experience. Second, our approach enables early recognition of nuances in customer sentiment and demonstrates a novel method for analyzing textual data from CRM and social media data. This will allow an organization to monitor the customer experience while cross-referencing internal and external data sources. Third, extracting employee evaluations and the customer–buyer relationship will be demonstrated in an approach that can be used on 'big data', building on text-mining

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_10

methods relating to the customer experience. Finally, we believe this new approach will enable firms to create rich, dynamic, customer-centric models that can provide a deeper understanding of customer behavior, including subsequent customer responses to organizational attempts to improve the customer experience.

**Keywords** Customer experience · Text mining · CRM · Data analytics · Customer feedback · Customer journey · Touchpoints · Marketing metrics · Employee feedback

## 10.1 Introduction

A major challenge for established organizations is understanding the customer experience and journey over time. Customers now interact with firms through myriad touchpoints in multiple channels and through digital media, and customer experiences are more social in nature (Lemon and Verhoef 2016). In fact, research conducted by Gartner found that 89% of companies plan to compete primarily on the basis of the customer experience (CX). Moreover, poor customer experiences result in losses worth approximately $83 billion by US enterprises each year because of defections and abandoned purchases (Mediapost 2010). Many researchers and managers recognize the need to invest in CX to remain competitive in an unforgiving service environment (Lemon and Verhoef 2016; Lipkin 2016; McColl-Kennedy et al. 2015; Ostrom et al. 2015).

Despite this realization, however, there is no consensus among practitioners and academics on this important topic (Homburg et al. 2015; Lemon and Verhoef 2016; Verhoef et al. 2009). Consequently, there is no rigorous assessment of the metrics that should be collected to gauge the customer experience (MSI 2016). In addition, little research has focused on reducing friction or 'pain points' throughout the customer journey (Lemon and Verhoef 2016). Additional insights are needed to identify and reduce specific pain points, or sources of friction, in the customer experience.

Traditionally, tools such as customer feedback surveys, questionnaires and interviews are used by service managers as a method of measuring customer satisfaction and a company's future performance (Morgan and Rego 2006). However, these tools are used at the end of the customer experience journey, masking the underlying issues of concern, which form the basis for identifying improvements. Furthermore, a survey data set cannot offer real-time responses; therefore, organizations have to rely on other real-time customer data sources, such as social media, to identify critical pain points, to unmask underlying sources of friction at the various touchpoints and to provide deeper insights into critical touchpoints and how and where organizations can implement change to reduce friction more quickly.

The wide spread of social networking sites and virtual communities is not only shaping the customer's perception of brands, but also offering a range of, sometimes

conflicting, opinions and influences (Archer-Brown et al. 2015). Therefore, this type of customer data is an asset that needs to be managed using a systematic approach (McColl-Kennedy et al. 2015). Firms should analyze it to portray customers' satisfaction levels, allowing improvement measures to be put in place. These are the result of increasing customer satisfaction and strengthening company–customer relationships. As a result, new data-driven methods that could highlight what really matters in terms of driving customer satisfaction and delivering actionable insights, in particular, are a research priority and required within the services context (McColl-Kennedy et al. 2015; Ostrom et al. 2015; Rust et al. 2004), where customer data from multiple sources should be cultivated to realize customers' opinions of the services obtained. Therefore, having customer experience analytics that is capable of evaluating customer experience improvements using real-time data sources is crucial in the context of services.

In light of this, this chapter proposes systematic multi-methods using text mining and a cognitive computing approach to capture and analyze customers' data. In particular, the chapter will contribute to the understanding and management of the customer experience in at least three important ways. First, we build a new customer experience analytics that enables firms to identify critical pain points from real-time data and provide deeper insights into critical touchpoints and how and where the organization can implement change to reduce friction and improve the customer experience. Our analytics not only identifies the root causes of friction but also ranks the areas from most to least friction. Second, our approach enables early recognition of nuances in customer sentiment and demonstrates a novel method for analyzing textual data from CRM and social media, thus allowing an organization to un customer experience while cross-referencing internal and external data sources. Third, extracting employee evaluations and the customer–buyer relationship will be demonstrated in an approach that can be used on 'big data', building on the customer experience of text-mining methods. Finally, we believe this new approach will enable firms to create rich, dynamic, customer-centric models that can provide a deeper understanding of customer behavior, including subsequent customer responses to organizational attempts to improve the customer experience.

The remainder of the chapter is structured as follows. First, we introduce CX and its linkage with customer relation management, customer engagement and big data. We then explore the case study and the proposed method. This is followed by the findings and analyses. We conclude with a discussion of the implications and a future research agenda.

## 10.2 Customer Experience

It is acknowledged that simply offering products or services alone is no longer sufficient to keep pace in an increasingly competitive market. Providing a satisfactory customer experience is now a requirement in business (Berry et al. 2002). Firms are challenged with fast-tracking media and channel fragmentation, and omni-

channel management has become the new norm (Brynjolfsson et al. 2013; Verhoef et al. 2016). Moreover, customer interactions through social media are creating significant challenges and opportunities for firms (Leeflang et al. 2015; Libai et al. 2010). To achieve customer satisfaction, a business must both understand the drivers of customer value and manage the customer–buyer relationship proactively (Bolton and Lemon 1999).

The strategy of Gouthier and Schmid (2003) for customer retention management states that businesses should aim to strengthen customer–buyer relationships with satisfied customers and stabilize relationships with dissatisfied customers. Therefore, the Marketing Science Institute considers customer experience to be one of the more challenging areas of research in the coming years because of the complexity of customer touchpoints (MSI 2010). Given the relatively fragmented state of the customer experience literature, we focus on the most accepted definitions; according to Lemon and Verhoef (2016), the 'customer experience is a multi-dimensional construct focusing on a customer's cognitive, emotional, behavioral, sensorial, and social responses to a firm's offerings during the customer's entire purchase journey'. In the following sub-sections, we will discuss the link between customer experience, customer relation management and customer engagement using social media and big data.

### *10.2.1 Customer Experience and Customer Relation Management*

Customer relationship management (CRM) has traditionally referred to a company managing the relationships with its customers (Malthouse et al. 2013). The contribution of the CRM literature to customer experience focuses on how specific elements of the customer experience relate to each other and to business outcomes (Lemon and Verhoef 2016). Organizations possess substantial information about their customers, which they use to manage their relationships with them (Payne and Frow 2005). Specifically, the company seeks to leverage customer information in order to measure customer profitability and customer life value (CLV), to build strong long-term relationships with customers and to cultivate customer relationship management and customer value management (Kumar and Reinartz 2006; Reinartz et al. 2004) and the resulting customer equity (Berger and Nasr 1998; Malthouse et al. 2013; Schulze et al. 2012). However, Meyer and Schwager (2007) pointed out that, although companies typically hold much quantitative CRM data on customer buying habits and classifications, little is known about the emotions of these customers and their evaluations. This is a current problem for businesses, and it is therefore no surprise that it can be easy for customer dissatisfaction to become widespread.

This suggests that understanding the customer experience is more complex than simple CRM metrics alone. In particular, much customer relationship and churn

management literature has used transactional data to predict customer loyalty (Neslin et al. 2006; Hopmann and Thede 2016; Wübben and Wangenheim 2008) in many sectors. However, Verhoef et al. (2009) agreed that customer experience is complicated and holistic in nature, encompassing cognitive, emotional and social characteristics, as well as the user's quantitative interaction with the business. Similarly, Payne et al. (2008) stressed that customer experience is shaped by cognitive, emotional and behavioral factors. They also emphasized the importance of co-creation of value to enhance and develop customer–buyer relationships. Yet companies are currently unable to gauge customer–buyer relationships, leaving them 'in the dark'. More recently, customers have started to interact with firms through myriad touchpoints, emphasizing the importance of monitoring the experiences that originate from these touchpoints (Gentile et al. 2007; Lemon and Verhoef 2016; Verhoef et al. 2009).

### *10.2.2 Customer Experience and Social Engagement*

The rise of social media is challenging the traditional concept of customer relationship management (CRM) (Malthouse et al. 2013). With the growth of social networking platforms, the customer is no longer limited to a passive role in his or her relationship with a company. In addition to having more information about competitive products, customers can easily express and distribute their opinions to large audiences, and companies are likely to find it increasingly difficult to manage the messages that customers receive about their products or services (e.g. Schulze et al. 2012). This new media offers many opportunities for organizations to engage with customers in real time and introduces a new channel for personalized and targeted communication (Bolton 2016). Organizations are becoming very active in using digital media to engage and respond to customers more quickly 1than by using the traditional channels.

Murdough (2009) discussed the use of social media for business measurement, and how a social media 'performance dashboard' that navigates the complexity of social media can give straightforward and instant insights to employees. Using social media to gain insights into products is, in itself, not a new concept. In the context of the health service, Freifeild et al. (2014) conducted an extensive study on Twitter into adverse drug events (ADEs), generating partially effectual results. They found that high-volume products perform better in analysis; however, their research was complicated, as automatic analysis required an understanding of clinical signs for ADEs for each drug monitored. Yang et al. (2015) performed similar analysis, identifying adverse drug reactions (ADRs) but using the popular medical health forum MedHelp. This study, as well as that of Paul and Dredze (2014), who took a broader look at health trends on Twitter, used a single statistical model—the latent Dirichlet allocation (LDA) model—instead of a linguistics-based approach. Ribarsky et al. (2014) discussed how social media analytics can be used for competitive advantage by looking at trends in Twitter conversational topics over

time, but they did not perform analysis on individual tweets to gain customer insights. Outside health care, more work has been done in extracting consumer sentiments from social media data. Pang and Lee (2008) looked in-depth at sentiment mining in social media data, including parts of speech (POS), negation, topics and syntax.

The aforementioned literature on customer engagement has overemphasized the benefits of customer engagement with the firm and ignored the customers' (Kunz et al. 2017) and employees' perspectives. For example, many studies have investigated the effects of brand community engagement (Algesheimer et al. 2005). They tested outcome variables such as brand-related purchase behavior and community recommendation behavior. However, their studies still lacked a focus on the customer and ignored the effects on individual customers (Kunz et al. 2017). For example, scholars such as Verhoef et al. (2010) investigated the impact of customer engagement on metrics such as customer retention, customer lifetime value and new product performance. Furthermore, Van Doorn et al. (2010) discussed the consequences of customer engagement for companies and did not discuss the benefits for customers; however, they did discuss certain financial benefits such as rewards and loyalty-based programs. Lariviere et al. (2013) introduced a new concept called value fusion, which explores the joint interactions and focus on the value derived for both firms and customers. Thus, customer experience design is essential to creating value for both the company and the customer (Addis and Holbrook 2001; Forlizzi and Ford 2000; LaSalle and Britton 2003; Prahalad and Ramaswamy 2004; Schmitt 1999; Smith and Wheeler 2002).

Furthermore, most research to date has studied social media as a communication tool rather than a research tool. It is noteworthy that social media allows businesses to both communicate with and understand their customers, including customer behavior and feelings (Woodcock et al. 2011), and market research can be performed through social media that can benefit an organization (Ang 2011). Indeed, Trainora et al. (2014) found that investment in social media technology can provide firms with substantial relationship management benefits, although this study didn't set out to understand in detail what methods were deployed. Haenlein (2013) provided evidence that when customers discuss complaints online, they are more likely to defect to a competitor if they see others doing so. It therefore stands to reason that the first stage of addressing these complaints is to understand when and why these pain points occur. Research has previously been conducted into so-called 'social CRM', and it is recognized that social media holds enormous potential for companies to get closer to their customers (Heller Baird and Parasnis 2011).

### *10.2.3 Customer Experience and Big Data*

The complexity of using technology within an organization's myriad touchpoints has led to a data explosion across touchpoints in the entire customer journey (Lemon 2016). We argue that service researchers will serve their organizations and

customers better if they play an active role in updating management of the customer experience using big data techniques. Firms could benefit from the use of more sophisticated and advanced modelling approaches, which have the potential to uncover patterns in customer data and to link with business results (Aksoy 2013; Hartmann et al. 2016; Kunz et al. 2017; Lemon 2016; Lemon and Verhoef 2016; MSI 2016). In order to improve the customer experience, firms must first be able to effectively understand what matters most to their customers in order to measure and model the customer experience adequately. Service managers have become increasingly aware of the importance of analyzing unstructured data, especially textual data generated from digital platforms and feedback systems (Ordenes et al. 2014). Computer science and information systems disciplines have introduced techniques such as natural language processing and machine learning techniques to analyze this textual data (sentiment analysis); yet, companies have failed to gain managerial insights by adopting these methods (Fenn and LeHong 2012). At the same time, the use of text mining has largely focused on developing more accurate models for automatically predicting the sentiment embedded within the text (Taboada et al. 2011).

Therefore, Pang and Lee (2008) utilized text mining to extract sentimental insights from customer data to improve customer loyalty measurement. Tirunillai and Tellis (2014) used text analytics to understand the dimensions of product quality in order to gain insights into brand positioning. Using longitudinal data on product reviews across firms and markets, their study extracted specific latent dimensions of quality, and the valence, labels, validity, importance, dynamics and heterogeneity of those dimensions. Ordenes et al. (2014) proposed and demonstrated a linguistics-based text-mining approach to extract customer feedback from survey textual data, to gain a better understanding of the customer experience. In particular, the text-mining model captured customer activities and resources, company activities and resources and customer sentiment (compliments, complaints) from the customer satisfaction data. Using this approach, customer data can be not only categorized as positive, negative or neutral, but also mapped onto a chain of activities and resources that describes how value is co-created using the voice of the customer.

Wyllie et al. (2016) used a small-scale descriptive network analysis approach to study stakeholder networks. They extracted network data from the social media brand pages of three non-for-profit health service organizations from the U.S., U.K., and Australia, to visually map networks of 579 social media brand pages. The approach provides service organization with a technique to assess and mange stakeholder networks.

Together, this nascent stream of research suggests that there is a real need for a 'total system/multi-dimensional' approach in terms of indicators capturing the customer experience (both attitude and response to offering), which would help companies to succeed in the long run, and to understand the root cause of customers' pain points in order to identify the best strategic actions. Furthermore, this review highlights a critical research gap, which is that customer experiences are dynamic, complex and social in nature and that firms should consider 'big data' technologies to understand the customer journey and the critical moments in that journey—in real

time, and in context (Lemon and Verhoef 2016). However, to date the big data methods have been used to analyze the sentiments related to customer experience (positive/negative/neutral). This is not comprehensive, and it is therefore essential for firms to undertake detailed investigations.

This chapter seeks to fill this gap, and to further our knowledge of the customer experience using a data-driven approach. In particular, this study builds on and extends the study of Ordenes et al. (2014) using a linguistic-based text-mining approach that combines qualitative data (text analytics) on specific customer experience touchpoints and aims to capture the emotional factors linked to the customer–buyer relationship by extracting both customer and employee evaluations and sentiments from the textual data, as well as customer feedback and pain points. Additionally, this research seeks to determine the stage of the customer–buyer relationship that is ongoing in each conversation, although in some contexts this may not be possible. Understanding this dimension is an important component of the customer experience (Dwyer et al. 1987). This chapter sets out to demonstrate the power of combining CRM and social media with a big data text-mining method. Barton and Court (2012) stated the importance of using multiple data sources—both 'internal and external'—in order to benefit from big data. This project concurs with this call and seeks to gain insights using a combination of CRM and social media data. The proposed approach helps service firms to identify critical pain points from real-time data and to provide deeper insights into critical touchpoints and how and where the organization can implement change to reduce friction and improve the customer experience. The text-mining method extracts not only customer evaluation but also employee evaluation and the customer–buyer relationship. We believe this new data-driven approach will enable firms to create a rich and dynamic customer-centric model.

## 10.3 Methodology

The study focuses on a business-to-business (B2B) complex service, whereby a wide range of elements of the customer experience is evident through analyzing a customer data set from a large international B2B animal health service organization. The goal of the study is to identify customer evaluations, emotions and pain points through a combination of textual CRM conversation data and online comments on social media. The method and modelling required in this project consist of several stages and are derived from the structure given in the Cross Industry Standard Process for Data Mining (CRISP-DM) described by Chapman et al. (2000). As shown in Fig. 10.1, this framework has been modified to reflect the process of using a combination of internal CRM data and external social media data. The method first gains an understanding of the business to determine why the motivation exists for this novel approach of combining data sources to monitor customer experience and identify pain points.

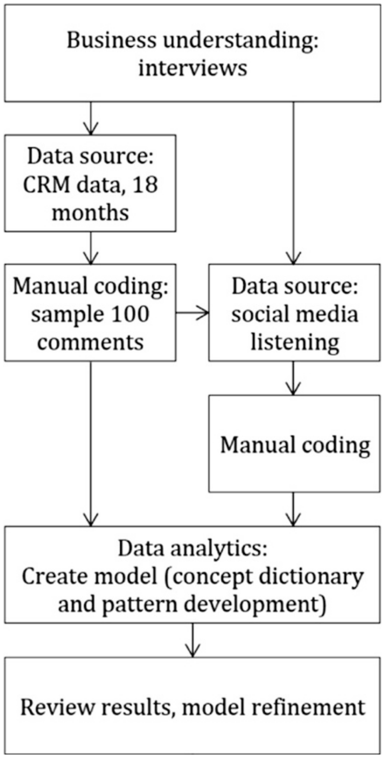


**Fig. 10.1** Research methodology overview

## 10.4 Case Study

We collaborated with one of the leading animal health pharmaceutical organizations. We conducted semi-structured interviews with seven employees, representing the Business Intelligence, Market Research & CRM, and Digital Innovation divisions. The aim of the interviews was to help us at the business understanding stage, to understand the organization's relationship with its customers and the different digital services that are offered to consumers, and to obtain an overview of its strategy in this area.

On the basis of these interviews, it is clear that the participant organization's sales team is primarily engaged in business-to-business relationships, but sales are also influenced by a business-to-consumer relationship. Regarding the business-to-business element, the firm employs a number of sales representatives ('sales reps') who regularly visit vet practices, as well as some other licensed merchants or large farms. The sales reps sell animal drug products and many digital services and encourage an ongoing relationship with the client. For business-to-consumer, the end users for the majority of the organization's products and services are consumers who own animals (pet owners, horse owners, farmers). Usually the final say in whether to buy a medication lies with the consumer and is influenced by price and awareness of any

pre-existing product reputation. In order to win trade and keep customers satisfied, vet practices may respond to consumer demand.

The company collects call notes from sales reps on every customer conversation held and stores these notes in a CRM database. Currently, this data is used only to help set the aims and discussion topics for future visits to a customer. No large-scale text-mining analysis of these comments has been performed. The company does track some of its products on social media, but current practice only looks at quantitative figures or reviews individual messages. Additionally, the task of controlling some of their social accounts (Facebook, Twitter profiles, etc.) is outsourced, resulting in a lack of visibility regarding these customer interactions. As a result of the nature of the participant organization's dual business-to-business and business-to-consumer relationships, no one source of data is sufficient to give insights into the overall business model. Instead, two strands of data analysis were undertaken, using both the internal CRM data and external social media data to investigate their relationship with consumers.

### *10.4.1 Data Sources—Understanding and Quality*

Every time a sales rep visits or telephones a client, this meeting is recorded in a database. The data used in this study contained notes made over an 18-month period, spanning 1 Dec 2014 to 26 May 2016. The data table received from the participant company contained 107,245 rows of data for this period. The provided data contains Account ID, which is the unique identification for each client; Type is the business sector that each client could be classified to (e.g. vet, farm); Attendee ID is the individual member of the client organization that the sales team met; Discussion ID is the promoted product that each sales team is trying to sell; Activity data is the date of the visit or telephone call; Call objectives is the recorded text that describes the call or meeting objectives; Call notes is a summary of the call, as reported by the sales team; and Next call objective is the recorded text that describes the objective of the next call. On the whole, the recorded data in the CRM is for B2B customers.

To collect data for B2C relationships, we crawled data from the social media sources. Unlike the CRM data source, the collected data from the social media networks and other online sources is completely unstructured and contains many more artefacts in the form of noise and ambiguity (Zeng et al. 2010). The biggest challenge with consumer-generated content is harvesting the relevant data: on Twitter alone, users post around 500 million 'tweets' per day. Furthermore, when preliminary social media listening was performed for a broad variety of animal and animal health terms, a great majority of conversations (80%) were found on Twitter. Geographically, the majority of conversations (48%) were from the USA, with Europe accounting for 15% of the content (both these figures exclude conversations of unknown geographic source, which constitute 19% of the total).

We evaluated the quality and suitability of all the data sets. For example, conflicting Discussion IDs were used as a result of the migration from the CRM

legacy system. Historically, Discussion IDs have generally been suffixed by '-MPG' (an internal abbreviation for 'Major Project Group'), but not all Discussion IDs followed this convention. For example, the Discussion ID 'Stronghold' was used 3772 times, while the Discussion ID 'Stronghold-MPG' was used a further 1356 times. In a couple of rare cases a Discussion ID had a double suffix, namely, '-MPG-MPG'. These suffixes were all stripped from the Discussion IDs: the number of unique IDs used fell from 369 to 208. As a result of redundancy in the received database, there was a lot of duplication of content. This is because a single meeting between a sales rep and a client might have several entries in the data table to allow multiple Discussion IDs and Attendee IDs to be recorded. To reduce the redundancy of the data table, these multiple rows were condensed into a single row for each meeting. Discussion IDs and Attendee IDs were concatenated on the new meeting data row where applicable. This reduced the 107,245 rows of data significantly, to reveal 24,290 distinct sets of meeting notes.

The crawled social media data has the limitation that each message downloaded appears to be restricted to a maximum of 320 characters in length of content (observational evidence). This is not a problem for posts on Twitter, as they are each limited to a maximum of 140 characters, but when analyzing blog and forum posts, subsequent content is omitted. Links to each source are given, so it is possible to read the full content—but currently only by a manual process. Furthermore, posts on Twitter often use emoticons to express sentiments (for example, 'Not many know but this horse battled laminitis and won ♥♥♥'2). To gain an understanding of approximate data volumes available, social media listening was carried out for four animal health conditions for a 93-day period (09 Feb–11 May 2016 inclusive). Symptom and condition keywords were used, not treatment names (generic or proprietary), and results were refined by adding exclusion keywords to remove irrelevant conversations. The following conditions were monitored: (1) Atopic dermatitis (4171 messages) is an inflammatory skin disease caused by allergic reactions to substances in the environment, resulting in chronic itching in dogs. Its prevalence is very approximately 5–15%; (2) Equine laminitis (620 messages) is a disease of the foot which is the most common cause of lameness and disability in horses in the UK. It can be cause by overeating/obesity, toxemia occurring as a result of another disease, or from trauma/mechanically induced; (3) Feline Vomiting (28,359 messages) in cats happens for a number of reasons, and may be the sign of a disease or parasitic infection; (4) Swine castration (307 messages)-male pigs are castrated to control aggressive behavior in adults, and to improve meat quality by avoiding "boar-taint". Boars are castrated soon after birth. Instead of castration, a vaccine, Improvac, can both prevent boar taint, and reduce aggression. It is apparent that the volume of data varies considerably between conditions. It is perhaps unsurprising that companion animals are more prevalent in social media than equine or livestock (based on this sample). This data indicates there is likely to be sufficient social volume for the higher selling companion animal medications, where insight can be gained from further integrated CRM social media investigations.

### 10.4.2 Text-Mining Model Development

In order to develop the text-mining model, first, we had to perform manual coding on the data. The manual coding followed the method of Ordenes et al. (2014), but this study extended their approach by capturing more emotional factors related to the customer–buyer relationship, extracting both customer and employee evaluations and sentiments from the textual data, as well as customer feedback and pain points. To ensure every comment contained sufficient information to be analyzed, short comments in CRM data were excluded before a random sample of 100 comments was taken. In social media data, excluding short comments would almost exclusively penalize Twitter posts, and therefore no exclusion took place when sampling. All comments in the sample were split into discrete 'units of information', where each unit was a phrase or sentence conveying one distinct idea, as defined by Singh et al. (2011).

In the CRM data, a total of 510 units of information were derived from the 100 comments. Each unit of information in the CRM was manually annotated based on Ordenes et al. (2014) to identify disease, value creation elements: resource (for OEM, competitor and the customer), which was typically a product (often medication) or service offered, and the customer resource was most often a specific animal or animal group (e.g. 'three possible herds'); activity (OEM, competitor, customer), which is defined as 'performing' or 'doing'; and context, which is personal or situational. We extended the annotation schema to involve the customer experience emotion elements introduced by De Keyser et al. (2015), including cognitive, emotional, physical, sensorial and social factors. Furthermore, we incorporated the customer interaction (person, type, duration) elements introduced by McColl-Kennedy et al. (2012), which are the ways in which customers engage with the company. The customer–buyer relationship describes the stage of the relationship between the sales rep and the customer, based on the model of Dwyer et al. (1987). The stages used in this analysis were:

1. *Awareness*—recognition of the other party as a feasible exchange partner: first meetings; introductions to completely novel product lines or services (e.g. PetDialog app; Profit Solver service).
2. *Exploration*—consideration of obligations, benefits and burdens in the relationship. In this analysis two sub-categories were used: attraction—initial conversations outlining product benefits, typically when attempting to win back business or expand the product range sold; and communication and bargaining—discussion of products and services in detail; agreeing financial arrangements; developing a working relationship. The majority of units of information fit into this subcategory. Conversations in this subcategory could often be split into those focusing on price—discussions about value, including price promotions; and features—discussions about product benefits and comparison with competitors' offerings.
3. *Expansion*—expanding interdependence: switching to use more of the firm's products; changing a product from secondary to primary choice for a particular health condition.

4. Co*mmitment*—pledge of continued relationship going forward: promise of future service; signing of contract for future sales.
5. *Dissolution*—moving to a competitor's product. As with exploration: communication and bargaining, reasons for dissolution could often be grouped into (1) those switching because of price, or (2) those moving as a result of features.

The customer evaluation is classified based on Ordenes et al. (2014): (1) compliment—customer described as actively praising the firm, its products or services; customer being described as 'positive about' a product or service; customer being 'very interested' to know more or arrange a follow-up; (2) complaint—customer detailing problems with a product or service (price, efficacy, etc.); customer expressing annoyance, disappointment or anger towards the firm, its products or services, or the sales rep; and (3) neutral—customer having a mild interest in a product or service; customer mentioning a product or service without a strong sentiment being expressed.

In addition, we expanded the evaluation to employee (sales rep) sentiment: (1) positive—a sale is made; sales growth is reported; customer shows interest in products or services; customer gives praise towards the company, its products or services; a follow-up meeting is arranged, networking (relationship-building) discussions; (2) negative—customer switches to a competitor; sales reported to have fallen; customer makes a complaint (as detailed above); and (3) neutral—sales both growing and falling (e.g. a shift from Cerenia tablets to injections); discussion with no strong sentiment being expressed.

As well as being determined on a per unit basis, customer and sales rep sentiments were also determined for each comment as a whole. This involved reassessing the whole comment and not 'averaging' the sentiment from individual units of information, as the latter technique did not always reflect the overall sentiment of the call because some units of information were more significant than others towards the general tone. As a result of the lengths of some of the comments, different coders might not always agree on the overall sentiment, as this is partially a subjective decision. When this process is automated, a sentiment-weighting system for units of information should be determined; in different cases the weight of negativity in a comment can vary, for example, 'switching to competitor' is very important, but 'has some concerns' is less so.

When using social media data, on average, fewer units of information were present in each comment—in part due to the prevalence of Twitter, which limits many comments to 140 characters, which is typically no more than 3 units of information. Social media data was manually coded similarly to the CRM data, but with a different set of classifications for words and phrases. Annotations were made to identify: medical ailment, medication (OEM and competitor), medication activity (OEM and competitor), company activity, customer activity, animal (type or name), animal activity, customer activity, interaction individual, frequency/time, and emotion (positive/negative/neutral). Then, author type (pet owner/vet/news etc.), customer evaluation (compliment, complaint, neutral) and customer evaluation pain points were determined. Only one evaluation and root cause (pain point) was

| Comment | Unit of Information |
|---|---|
| John using Advocate in dogs due to lungworms, had a couple of positives so have doubts about Advocate now. Cerenia for motion sickness discussed also ...really liking and using more. | **John using Advocate** in **dogs** due to **lungworms**, had a couple of positives so **have doubts** about **Advocate** now. |
| | **Cerenia** for **motion sickness discussed** also ...**really liking** and **using more**. |

| Disease | Company resource/ product | Company activity | Customer resource/ animal | Customer activity | Competitor name | Competitor activity | Positive emotion | Negative emotion | Neutral emotion | Interaction with person | Interaction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| lungworms | | | dogs | | Advocate | using | | Have doubts | | John | |
| motion sickness | Cerenia | | | | | using more | really liking | | | | discussed |

| Touch point | Customer-buyer relationship | Customer evaluation | Customer pain point | Employee evaluation | Employee root cause |
|---|---|---|---|---|---|
| Sales: Companion Animals | Exploration: Communication and bargaining: Features | Complaint | Stronghold efficacy, Advocate efficacy | Negative | Using competitor, Switch unlikely (lungworm) |
| Sales: Companion Animals | Exploration: Communication and bargaining | Compliment | Cerenia | Positive | Cerenia sales |

**Fig. 10.2** Manual coding

taken from each unit of information because social media comments are written by a single individual, unlike CRM data, which is written about a conversation between the customer and the employee (Fig. 10.2).

### 10.4.3 Text-Mining Library

To automate the text-mining process, we developed linguistic patterns using the text-mining model. We used IBM SPSS Modeler, with its Text Analytics platform. Although this platform contains several built-in analytics libraries, none were

sufficient for use on this CRM or social media data—in the best case 75% of words and phrases were of 'unknown' type. This shows why firms must develop a domain-specific library and patterns that could generate meaningful insights.

The first stage of creating an automated text analysis system is to build a library of terms. A library contains several different 'elements', each representing a different resource or activity. These elements are taken from the manual coding process annotation classifications. The annotated words and phrases from comments are then added as terms to their respective elements in the library can be single words (uni-terms) or short phrases (multi-terms), as identified during manual coding. Spelling mistakes are resolved using a synonym library that links equivalent terms; a record of spelling mistakes found was made during manual coding and these were entered as synonyms. The distinction between our participant firm and the competitors' products is important when understanding customer sentiment, but identification is sometimes contextually challenging. For example, in the comment 'Not looking great for vaccines', a customer currently uses our participant firm's vaccines and is considering a switch to a competitor, but in 'Wouldn't switch vaccines', the customer currently uses a competitor and is unwilling to switch to our participant firm. This is not clear from the term alone and needs a wider context to be considered.

As a result, our participant firm and competitor resource terms were categorized into three elements: <FirmResource> (93 terms), <CompetitorResource> (63) and <CompanyResource> (44). The first two elements contain brand names (e.g. 'Veriscan') and unambiguous phrases such as 'our vaccine' or 'competitor vaccine'. The last element contains terms such as 'vaccine' that can only be identified in context. Other resource elements in the library are <Disease> (47 terms), <Animal> (27) and <InteractionPerson> (5212 terms; a list of common names was combined with the manual coding terms). Of equal importance to the resources is the set of elements that describe activities: <CompanyActivity> (164 terms), <CustomerActivity> (318) and <Interaction> (567 terms). CX Emotions are another key component of the library. This library has 14 elements, which allow a more exact classification of positive and negatives terms, for example, <PositiveBudget>, <PositiveAttitude> and <PositiveFeeling>. This level of detail assists during the following stage of the process, when building linguistic phrase.

### 10.4.4 Text-Mining Developed Patterns

In this stage, we developed linguistic patterns using the elements defined in the library and the relationship between them (resources, activities, CX emotions, customer–buyer relationship). First, a series of 26 macros were made to define sets of words that were not needed as elements but, when identified, simplify the process of extracting word strings. For example, parts of speech (adverbs, prepositions etc.), negation (e.g. 'not' a positive), words for 'having' or 'being', among others, synonyms of 'however', 'because' and 'probable', among others, and also grouping

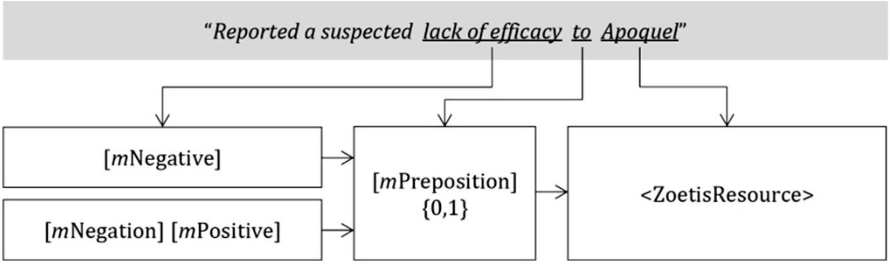


**Fig. 10.3** An example of the Linguistic pattern development

elements such as a positive and a negative group. Using the macros and dictionary elements, sentence patterns could be constructed. Every pattern was assigned to one of the customer evaluation categories to identify pain points. In Fig. 10.3, a simple pattern is demonstrated that classifies a negative comment about our participant firm:

1. The phrase 'lack of efficacy' is classified as a <NegativeFunctioning> element and is picked up by the [mNegative] macro, which includes all negative opinion elements.
2. The [mPreposition] macro is an optional part of the pattern, signed by the {0,1}.
3. 'Apoquel' is a medication classified as a <CompanyResource> insights.

Text mining is an iterative process, so once the model has been trained using the sample set of data, a new sample data set from the CRM database is tested which allowed the results to be reviewed and changes made to refine the model.

## 10.5 Findings

In this section, we demonstrate how our text-mining model generated insights from the CRM and social media data.

Discussion ID Analysis—the suggested approach provides an understanding of what topics have been discussed at each call. The 24,290 calls each have one or more Discussion ID recorded (with a mean of 1.90 Discussion IDs per call over the data set). Table 10.1 shows how often popular topics were discussed according to this figure. Apoquel tops the table, with just over 20% of calls discussing this medication.

However, these results can be called into question by looking at the free-text call notes and listing which products have been mentioned. We found that in some cases the call notes corroborated the Discussion ID. In other cases, the call notes did not mention a topic that existed in the Discussion ID. This does not necessarily mean that the Discussion ID topic wasn't discussed, but rather that no notes on the discussion were written. In many instances, the call notes contained a topic where a matching Discussion ID was not given. Where a matching Discussion ID existed (on other calls), but was not used on this call, there was a clear inaccuracy in the

**Table 10.1** The most popular Discussion IDs in the CRM database

| Discussion ID | Proportion of calls |
|---|---|
| *Apoquel* | 20.1% |
| *Versican Plus* | 11.2% |
| *Stronghold* | 8.9% |
| *Rispoval Intranasals* | 8.3% |
| *Cerenia Tablets* | 6.4% |
| *CIDR* | 6.4% |
| *PetDialog* | 5.7% |
| *Orbeseal* | 5.1% |
| *Cydectin LA Sheep Injection* | 4.9% |
| *Vanguard 7* | 3.7% |
| *Convenia Injection* | 3.4% |

**Table 10.2** The topics discussed most in the sampled CRM comments where a matching Discussion ID was not present on the call

| Topic | Proportion of calls |
|---|---|
| Apoquel | 13% |
| Convenia | 13% |
| Profit Solver (Business Dev.) | 6% |
| Draxxin | 5% |
| Orbeseal | 4% |
| Simparica (inc. 'parasiticides') | 4% |
| Stronghold | 4% |
| PetDialog | 3% |
| CIDR | 3% |

Discussion ID data. By finding the number of times a topic was mentioned in a comment, having not been mentioned in the discussion ID, the extent of this problem could be determined. To test the extent of the problem, the number of times topics were mentioned in the comments, but not in the Discussion ID, was investigated. The results, shown in Table 10.2, suggest that there is a widespread problem of missing Discussion ID data.

According to Discussion IDs, Apoquel was discussed in 20% of calls in the CRM database (in the sampled data this figure was 21%), but a further 13% of calls in the sampled data (a 65% increase) discussed Apoquel without its Discussion ID being present. The most affected Discussion IDs were Convenia and Business Development (mentioned as Profit Solver), which each saw an approximately 400% increase in the number of conversations. It is unclear whether these additional conversations were brought up by the customer or the sales reps during meetings—some evidence exists for both cases but for many more it is not apparent.

***Customer and Sales Rep Sentiment***—Customer sentiment was often unclear in units of information (61%), as shown in Fig. 10.4. Of units where sentiment could be determined the sentiment was split fairly evenly, with compliments 16%, neutral 12% and complaints 11%. For the sales rep, sentiment was easier to establish, leaving only 17% unclear. Instead, the majority of results were positive (46%). This is partly due to many calls containing units of information classed as

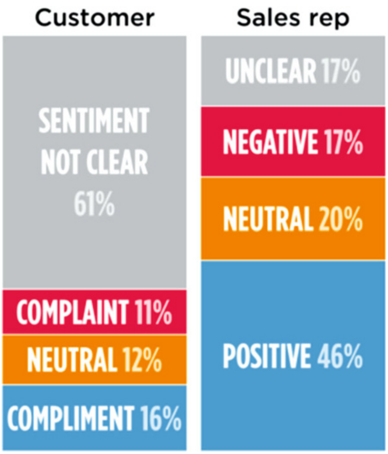


**Fig. 10.4** Sentiment analysis per unit of information

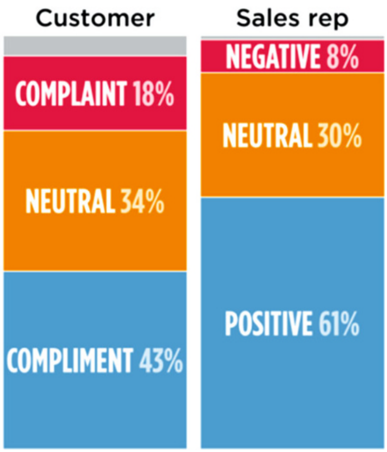


**Fig. 10.5** Sentiment per whole message

'Networking' or arranging a 'Follow up'—both of which met the definition of positive sentiment for the sales rep. There were 20% neutral and 17% negative units of information. Where both customer and sales rep sentiment could be defined for a given unit of information, the sentiments matched in most cases (78%).

When the whole call message was analyzed and a sentiment given, there were very few unclear sentiments (just 5% of customer sentiment and 1% of sales rep sentiment), as shown by Fig. 10.5. This is because, over a whole conversation, overall sentiment becomes clear even when not all the component units of information have an apparent sentiment. For both the customer and the sales rep, most calls are rated positively. This is because negative parts of the call (units of information) are often resolved through the call and ultimately outweighed by the positives.

Where both customer and sales rep sentiment could be defined for a given whole message, the proportion of sentiments that match fell to 63%. Visually, there appears to be a straightforward positive skew on the data from the sales rep. To check that

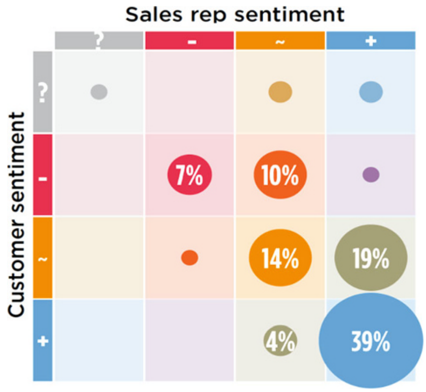


**Fig. 10.6** Matrix showing customer sentiment against sales rep sentiment for each whole message

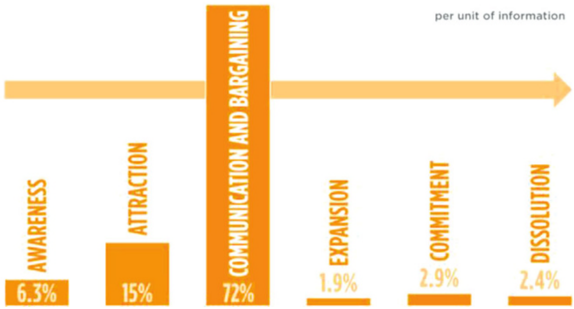


**Fig. 10.7** Customer–buyer relationship stages

there are no significant mismatches in evaluations, the customer and sales rep sentiment can be plotted in a matrix, as shown in Fig. 10.6. This shows that almost all mismatches are complaint/neutral or neutral/positive. The Director of the digital center at our participant company confirmed that this skew is reasonable, as sales reps work to make sales and will therefore maintain a fairly positive outlook.

***Customer–Buyer Relationships***—It should be noted that, because of the business model of the participant company in the UK, sales reps cannot easily find commitment, as most products are sold and distributed via wholesalers, not the company itself. The firm can receive commitment to their subscription services (Profit Solver, PetDialog etc.) and on some medication promotions (e.g. an Apoquel promotion was running during part of the CRM sample period). Given this scenario, and the customer–buyer definitions used, the relative volumes shown are broadly consistent with expectations (confirmed by the Director and the Programme Manager of the digital center). Generally, 72% of the sales reps try to *communicate* and *bargain* with customers, followed by 15% of the conversations or the visit objectives attracting them to our participant company product and service. Interestingly, only 2.4% appear to be switching and dissolving and are no longer interested in the participant company service or product portfolio. However, only 2.9% are committed to the product or the services of this company. Only 6.3% of these conversations are making customers aware of new or suitable products and services for customers (Fig. 10.7).

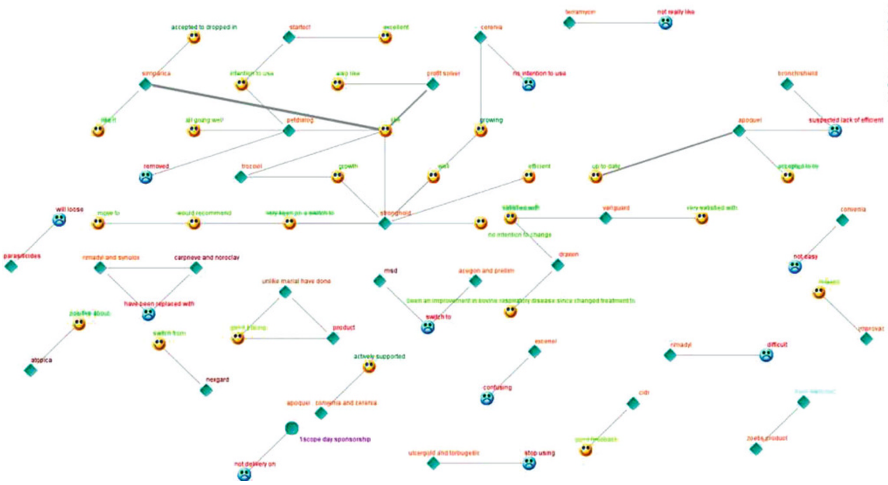

**Fig. 10.8** A snapshot of some of the Customer Pain Points Visualization

***Customer Pain Points***—The analysis identifies which particular aspects of the service received the most customer complaints. Figure 10.8 shows a snapshot of these pain points. First, the most recurrent discussion topic was *price*: 25% of calls showed that customers were concerned about price, including 14% for whom price was cited as the primary reason for not using the firm's products or services. Price was mentioned most often for two touchpoints: when trying to win sales, and when losing sales. ***Trying to win sales***—19% of customers were targeted for using a competitor product as the primary medication, in an attempt to get them to switch to our participant firm's equivalent. In 58% of these cases of trying to win sales, customers cited price as the main reason for using a competitor ('*Thinks that price is the reason they are not using our product*'), the main reason not to switch to our participant firm ('*Peter not really interested as they have plenty of options, would need to be very cheap or have better solubility*') or their main consideration if they were to switch to the participant firm ('*Would like to use Rimadyl but price dependent*'). ***Losing sales***—13% of customers told sales reps that they had just switched to a competitor ('*Synulox RTU—have switched back to Combiclav based on price*'), were about to do so ('*The plan in January is to switch to MSD dog vaccines and Merial cat*'), or were strongly considering switching ('*If discounts drop significantly on parasiticides we will lose that business as well*'). In 54% of these cases, price was given as the primary reason for the switch ('*Rimadyl and Synulox have been replaced with Carprieve and Noroclav on price…*', '*Mentioned Torbugesic as they used to use our firm's product but have switched due to price*').

A small number (3%) of comments mentioned the price competition that vet practices face with Internet pharmacies ('*Not interested in parasiticides as lose so much business to online*'). Vets must remain competitive or consumers will instead request prescriptions and purchase medication online. Vets profit by selling

medication; therefore, if too many consumers buy from Internet pharmacies, this incentivizes vets to switch to a cheaper competitor product that would discourage their clients from buying online (‘*He cannot compete with Internet pharmacies … [he] has to have a product that he can compete with*’).

Second, discussion of the *product supply* of the medication Apoquel was a clear pain point, it being mentioned in 11% of calls. Apoquel was launched in the UK in early 2014, but until mid-2015 suffered a series of supply problems resulting in repeated stock-outs. This meant that problems were ongoing during the early CRM data entries (which started in December 2014), but were resolved in the more recent entries. In the CRM data, 34% of conversations discussed Apoquel. Of these, 32% complained about, or sought information on, the Apoquel problems. Complaints being made while problems were ongoing are not surprising and indeed predictable (‘*Not particularly happy with Apoquel situation*’, April 2015), but what is of more interest is studying the reputational knock-on effect that the long-running problems may have had—with both vets and pet owners. In the CRM data, there is evidence to suggest that there were some communication issues when publicizing the resolution of Apoquel supply problems (‘*She called to check the status of Apoquel supply, advised now available*’, March 2016). In addition, some vets have made it clear that, in their opinion, our participant firm’s reputation has suffered as a result of the situation (‘*Still some residual disappointment with us as a company with product supply*’, February 2016). The social media data analysis confirmed that, even after all the supply issues had been resolved, 523 Apoquel supply problems were mentioned by customers. This is a 32-day period, 23 April to 24 May 2016, in which 14% of conversations showed a negative customer sentiment. Both in the CRM and social media data, there are ongoing discussions and negative sentiments as a result of the supply problems that existed—from vets and pet owners. This demonstrates the importance of continuing to monitor the customer experience over time.

The third pain point was the adoption of the PetDialog service application. PetDialog is an app for pet owners that feeds data about their animals back to their registered vet practice. This ability to view the pet data is sold as a service to vets. PetDialog was discussed in 12% of calls. This figure is made up of practices that are currently using the service (3%) and those who aren’t (9%). Although some of those who aren’t using the app showed an initial interest (‘*customer really likes it*’), most vets then fail to commit to the service. Some vets are unwilling to proceed because they are not convinced of its success (‘*He does not think it will work in their demographic areas*’), or because they are unsure about its functionality (‘*Customer had a play with the app and did find a couple of things that he wasn’t quite sure that he liked*’). There is also a question of the cost of the service (‘*Unfortunately he is decided at this point he does not want to pay for it as he feels it should be part of the offering with the vaccines*’). Furthermore, some vets would prefer to have confirmation of success from other practices before committing themselves to the scheme (‘*He is going to wait and see how it goes with other practices and ask them what their thoughts are*’).

We had access to the postcode of every UK vet practice that has signed up to the PetDialog service, and also the number of app users at each practice. The postcodes

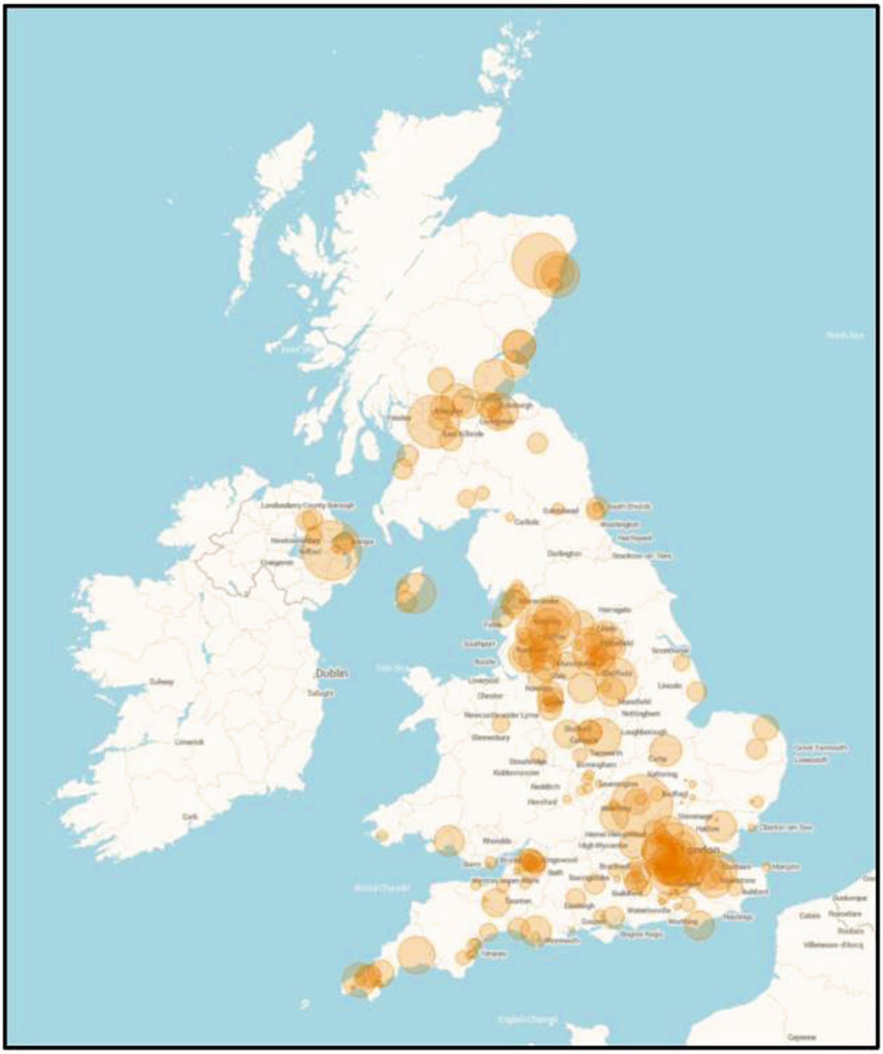


**Fig. 10.9** Geographic uptake of PetDialog. Each circle represents a vet practice (n = 237); circle size represents the number of app users (min: 1; max: 645)

were converted into coordinates and plotted on a map, as shown in Fig. 10.9; every circle represents a vet practice and the circle size represents the number of app users. As expected, there is some clustering in major densely populated areas, but there are also clear discrepancies. For example, Cornwall (population 500,000) has nine vets using PetDialog, while Wales (population three million) has only four—all along the south coast. Leeds and Birmingham have populations of 750,000 and 1.1 million respectively, and yet for each the nearest PetDialog practice is over 10 km from the centre. In contrast, Nelson, Lancashire, has a population of around 30,000 and has

four practices within 5 km. The sales rep teams are divided into regions across the UK. From this data, a credible hypothesis is that some sales rep teams are better or more persistent at selling PetDialog than others. In particular, the 'North-West of England' (Lancashire) team seem to do very well, and the 'North-East of England' (Yorkshire/Lincolnshire) and 'Wales' teams seem to do less well. For this theory to be validated, data on sales rep regional divisions for companion animals (unfortunately unavailable) should be cross-referenced. If confirmed, in order to address the problem, the company should consider a training programme whereby sales reps in underperforming regions receive training from sales reps in higher-performing regions—either in standalone sessions or perhaps by going on sales calls with them. Customer relationship managers should consider this and other possible solutions (and implications) further.

Social media listening was undertaken to try and understand consumer (pet owner) sentiment and pain points relating to use of the PetDialog app. This question formed part of a larger social media listening study, which extended to listening for other competing apps that have similar functionality to PetDialog. Key terms for competitor products were provided by our firm. Data was collected for a 90-day period (8 February to 7 May 2016). Some of the Twitter data gathered for the PetDialog brand is in the form of updates sent by users through the app. For example, tweets in the data sample were of the structure: '[Pet Name]'s latest photo addition. Captured in the PetDialog app connected to [Veterinary Clinic]'. Another tweet format used by the app appearing once in the data sample is: '[Pet Name] earned an [Achievement Name] badge with the PetDialog app connected to [Veterinary Clinic]'. Measuring the prevalence of these types of tweet over time could provide insights into engagement and deployment of the app if there were more data collected; however, these metrics can be recorded internally by the app and reported back to the participant firm.

## 10.6 Conclusion

We argue that our customer experience analytics will guide scholars and practitioners on how to understand the customer experience and how to gain insights from the extensive real-time 'big data' that arises throughout the customer experience. In particular, the incorporation of our finer-grained customer experience elements (resources, activities, interaction, interaction durations, emotions, customer–buyer relationship, contextual, suggestions) will help text-mining algorithms to capture specialized vocabulary used by the customers in the CRM and social media data. Furthermore, it is expected to be more effective in monitoring the customers' views for each touchpoint and identifying pain points rather than relying on algorithms or techniques using general English terms. Importantly, this chapter offers practitioners and academics a novel way to utilize data more effectively in order to provide a more in-depth understanding of the complexity of the customer experience, in addition to actionable insights for service science practice. We sought feedback

from the firm's management team about the usefulness of our model. The response was resoundingly positive. The Customer Experience Manager noted, "we must now capitalize on this model and we have to ensure knowledge is transferred over what is more surprising is the proportion of customers who do not use our product solely due to price". Further, the Service Director observed "This is a really great model to understand our priorities to deliver better customer experience."

However, we encourage future research to further test our model in other service contexts and with different languages and cultures. This study has showed how additional insight can be gained by linking CRM and social media data sources, cross-referencing results, and combining analysis. To validate insights further this method could be extended to include more data sources. Cross-referencing results of surveys sent to customers with the CRM data supplied by the sales reps will allow a comparison between the customer's stated sentiment and the evaluation given to them in the sales rep call notes. Survey data may either validate CRM sentiment analysis, or reveal a possible bias in how sales reps record conversations. There is also the possibility that some segments of sales reps (e.g. geographic team, or companion vs. live-stock) have different reporting biases. Future model should cross-reference the customer sentiment towards a product or a service with sales and profit data, which important in validating CRM analysis.

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# Part II
# Service Systems – On the Nature of Service Interactions

# Chapter 11
# The Future of Service Systems: From Synergetics to Multi-Sided Platforms

**Jennifer D. Chandler**

**Abstract** The purpose of this chapter is to frame the future of service systems at the theoretical intersection of synergetics and multi-sided platforms. The future, or propagation and evolution, of service systems requires an understanding of the pivots and modes by which the people, technology, and value propositions in a service system jointly evolve. A better understanding of this can emerge from applying the approaches of synergetics, or the enslaving and consensualization of service systems through order parameters (Meynhardt et al., J Bus Res 69:2981–2989, 2016), and multi-sided platforms, or the technologies that enable direct interactions among two or more groups (Hagiu, MIT Sloan Manage Rev 55:71, 2014; Hagiu and Wright, Int J Ind Organ 43:162–174, 2015). Together these two approaches enrich the study of the future of service systems.

**Keywords** Service systems · Synergetics · Multi-sided platforms · Temporality · Service

## 11.1 Introduction

The purpose of this chapter is to frame the future of service systems from the theoretical approaches of synergetics and multi-sided platforms. Synergetics refers to the influence of order parameters, and their enslaving or consensualization of people, objects and technology (Meynhardt et al. 2016). Multisided platforms refer to technologies that enable direct interactions among multiple otherwise disconnected groups (Hagiu 2014; Hagiu and Wright 2015). These approaches can inform the traditional study of service systems as "value-co-creation configurations of people, technology, value propositions" (Maglio and Spohrer 2008, p. 18). Together, they shed a different light on extant

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_11

interdisciplinary research from the service, information systems, computer science, and marketing disciplines that have typically focused on glimpses of systems as frozen in singular moments; these traditional approaches have tended to emphasize interconnectedness over time (Chandler and Vargo 2011).

However, to further develop service system research, it is necessary to focus on the future, or propagation and evolution, of service systems. Reducing the study of service systems to change or temporality among actors incompletely articulates how service systems move into the future. Instead, it is important to broaden our thinking about service systems in order to consider the complexity that arises when the pivots and modes of people, technology, and value propositions jointly evolve over time. They do not progress in a strict linear fashion; rather, there are feedback loops, multiplier effects, and emergent parameters to consider. There is not yet a comprehensive framework that advances service science in a way that accommodates these issues. The purpose of this chapter is to draw on concepts from synergetics and multi-sided platforms to explore the pivots and modes of service systems.

## 11.2 Synergetics

Inherently, the study of service systems is the study of value. Service systems are viewed, generally, as value-co-creation configurations connected by value propositions (Maglio and Spohrer 2008). A value proposition connects service systems together by inviting an actor to engage with another actor (Chandler and Lusch 2015). When offered a value proposition, an actor can choose to resist, reject, or accept the value proposition. By accepting the value proposition, an actor can become engaged with a service system. Value propositions in this way are the glue that holds a service system together. Value propositions invite engagement. Thus, without value propositions, service systems would not exist.

Based on this, when the value associated with a particular value proposition changes, it goes without saying that the system also changes because the nature of engagement in the service system has changed. However, it is difficult to fully understand the nature of this change because of its highly complex nature. It is complex because of the variety of ways that value propositions can be offered. Conversely, there are also many diverse responses that value propositions can elicit. This variety is at the foundation of the dynamic relationships that comprise service systems. As relationships and the nature of engagement change over time, so too does the service system. In this way, value and any associated value propositions also evolve over time.

Despite this, value has traditionally been studied as a singular phenomenological experience; it is typically viewed as an amorphous and fleeting emergence that is not situated in goods or things. Accordingly, recent studies have begun to underscore value as disparate from goods or things, or as an outcome of sets of processes (Normann and Ramirez 1998, Chandler and Lusch 2015). Because this is a rather new and different avenue of inquiry, it has not yet become clear how to best conceptualize value in this way, particularly with respect to service systems.

Synergetics offers a framework to this end; it outlines value as more than a passive by-product or emergence of processes. Synergetics proposes that value can be an active agent in evolving service systems when it, at times, behaves as an order parameter or organizing principle (Meynhardt, Chandler and Strathoff 2016). In this way, value can be viewed as a systemic property that, as it emerges, can evolve service systems. Because value comes about from the multitude of relationships among those involved in the "valuing", these relationships are also related to value. Thus, although each individual relationship in a service system houses a distinctive nature of value, value exists amidst a sea, or context, of these relationships (Chandler and Vargo 2011). It is a characteristic or property of those relationships. Stated differently, value can change or become different in response to these relationships, as they change over time. Consequently, value informs how engagement and the relationships in a service system evolve.

Synergetics explains how and why this occurs. An interdisciplinary concept, synergetics outlines when and how order changes in a system (Haken & Mikhailov, 1993). Furthermore, synergetics asserts that systemic properties are not necessarily the sum of a system's smaller parts: "They form a 'gestalt' which cannot be discovered by simply looking at the parts and adding them up" (Meynhardt, Chandler, and Strathoff 2016). Rather, systemic properties belong to the system as a whole but can influence different parts of the system differently. As a framework for exploring these influences, synergetics focuses on the self-organization or organic order in a system. It asserts that certain parameters can orient service systems to particular logics.

Integrating synergetics with service research, Meynhardt et al. (2016) propose nine systemic principles of value co-creation: *critical distance, stability, amplification, internal determination, non-linearity and feedback, phase transitions, symmetry breaking, limited predictability*, and *historical dependence.* These principles describe value co-creation from a systems perspective. Each of them coincides with a different phase or transition of a service system.

The systemic principles of *critical distance* and *stability* relate to systems that are at *equilibrium*. Specifically, critical distance refers to the propensity of systems to continue according to existing logics or orders. This is a phase when there is little change in a service system, when there is a sense of equilibrium. Meanwhile, stability refers to systemic resistances to perturbations or change. Referring to the same type of phase, the service system is stable, and the different components are synchronized which makes it difficult for perturbations to take root. In these situations, it can be argued that value is emergent from the stasis of the system.

Next, the systemic principles of *amplification* and *internal determination* relate to systems that are in *early transition*. Specifically, amplification refers to a state when fluctuations begin to randomly appear in a service system. These random fluctuations can be unexplained; they may occur then disappear without occurring again. Or, they may occur haphazardly without an apparent pattern. The effects of an unknown force or characteristic are being amplified in the system through the manifestation of these fluctuations. Relatedly, internal determination refers to the system's response to external forces via changes or dynamics at a system level. More or less, these two systemic principles underscore that early transition consists of a

system's unique, complex, and indeterminable responses to external forces or jolts. These two systemic principles outline that systems respond to external stimuli in different ways; two systems can respond very different to the exact same external stimulus. In these situations, it can be argued that value is no longer emergent because the stasis or equilibrium has been disrupted.

Next, the systemic principles of *nonlinear loops* and *phase transitions* articulate *systemic evolution*. Specifically, non-linear feedback loops facilitate either additive and multiplicative effects in systems; they are the pivots that can significantly shift logics and orders in service systems. Through nonlinear loops, systems adapt to external forces and are able to shift the inner workings synchronized among components. During phase transitions, systems can "transition from one stable state to another stable state" such that one equilibrium is replaced by a different equilibrium. In these situations, it can be argued that value has begun to emerge as a different order takes hold in the system.

Finally, the systemic principles of *symmetry breaking*, *limited predictability*, and *historical dependence* outline how *new systemic orders* are realized. Simply put, "new orders are realized only after an emergence has become established as an order parameter". Symmetry breaking refers to the evolution of emergences from seemingly inconsequential random fluctuations; only some fluctuations can become formidable order parameters that shape systemic components and properties. Limited predictability outlines that fluctuations can progress into order parameters, and that this progression cannot typically be predicted beyond the short-term. Moreover, historical dependence highlights that the future of a service system is best understood by looking to its past rather than looking to, or attempting to predict, its future. In these situations, value acts as an order parameter and organizes the service system. It enslaves, or consensualizes, the smaller parts of a service system (Meynhardt, Chandler, and Strathoff 2016).

## 11.3 Multi-Sided Platforms

Given the ubiquity of technology and social media, multi sided platforms are increasingly central to service systems in the new internet economy. Multi sided platforms are technologies, products or services that create value primarily by enabling direct interactions between two or more groups that are both customers of the multi sided platform (Hagiu 2014; Hagiu and Wright 2015). Multi sided platforms thus catalyze service systems by bringing two or more types of groups together.

Examples of multi sided platforms include eBay, Amazon, the Uber app, Sony's PlayStation, shopping malls, and credit cards. eBay for example is a multi sided platform that brings together buyers and sellers; without eBay direct interactions between buyers and sellers would not be possible. Similarly, credit cards enable direct interactions between retailers and their customers; without credit cards, retailers and customers would not be able to incur credit transactions. Other multi sided platforms include Facebook, Snapchat, and Netflix. Social media multi sided platforms often

depend on their users to both share content and consume content. All of this has become more prevalent in society because of information technology and cloud computing, which democratized the internet by enhancing its participatory nature.

Multi sided platforms work because they reduce search costs by helping disparate groups find or interact with one another, especially on the internet but also in real-time in real life. This is most apparent in the situation of Netflix where viewers can more easily find content because of the Netflix multi sided platform. After logging into a Netflix account, viewers are welcomed by a list of either their favorite content or recommended content based on viewing habits. On a different note, multi sided platforms reduce transaction costs by facilitating service fees rather than exchange or ownership fees. Netflix charges a flat monthly subscription fee, regardless of how much content is actually viewed. Consider how Facebook brings together content generators and content viewers; viewers can see content without necessarily owning the content, and, vice versa, content generators can share their content without necessarily collecting a fee from viewers. In these ways, multi sided platforms have proliferated service systems in the internet economy.

A concept from Economics, multi sided platforms are important to consider in the study of service systems because they explain economically how new actors are attracted to a multi sided platform service system: (1) to reduce search costs or (2) to reduce transaction costs. Furthermore, multi sided platform research emphasizes the network externalities that are characteristic of service systems. Network externalities have traditionally been overlooked in the service system literature, yet they are important because the value of an multi sided platform or service system depends on the number of customers in one group with respect to the number of customers in a different group. In other words, value typically increases with the number of customers in each group; for example, more content on Netflix generally attracts more viewers and thus increases the number of viewers of Netflix. This is a positive network externality that should create a cycle by which more and more actors (both content providers and viewers) join the Netflix service system. On the other hand, negative network externalities arise when the benefits of being associated with the service system decline as a result of increased numbers of actors. This could happen in the case of Netflix, for example, if the amount of content grew so large that the Netflix servers slowed down and caused viewers to become frustrated and leave the service system. It could also happen if the number of viewers grew so large that content became frequently unavailable due to licensing arrangements that limit the number of viewers per content.

As more service systems become centered on multi sided platforms it will be necessary to develop frameworks that explore how multi sided platform service systems evolve. Network effects can serve as a starting point for the study of this evolution. Thus, a deeper look into network effects can offer important insights in the study of service systems. To begin with, multi sided platforms are essentially value propositions; they are invitations to connect disparate groups into service systems (Chandler and Lusch 2015). For example, eBay is essentially a value proposition that invites engagement among buyers, sellers, products, and services; by accepting the invitation, buyers and sellers engage with and comprise the service

system. Their collective nature helps to define the service system. Accordingly, network externalities—either positive or negative—arise from the nature and number of buyers and sellers engaged with the value proposition. If eBay changes, so too would the collective nature of the buyers, sellers, and the products or services that they buy and sell. From an economics perspective, the quantity of buyers and/or sellers might change and this could influence the system as a whole.

By thinking about service systems in this way, the challenges that have become evident with multi sided platforms can also shed some light on the potential research opportunities related to the future, or propagation and evolution, of service systems. First of all, it has become difficult to evaluate the heterogeneity, or appropriate number of different groups, necessary to attract for a successful multi sided platform. In systems research, this has generally been regarded as a threshold or capacity issue. The heterogeneity issue however is different but related to these issues and also those of network externalities and number of actors within each disparate group (i.e., size of group). The effects of size and number on service systems and multi-sided platforms relate to more than just quantity. Aside from the number of groups as well as the number of actors within each group, consideration of variety among groups in its service system and the extent to which each group is different in terms of what is offered and what is being sought by those actors are also important factors. For example, typical Netflix content that has been offered tends to be professionally created content from big Hollywood studios that routinely create television shows and movies. What if Netflix began to offer amateur content such as independently created movies from international studios? How would this change the nature of the multi sided platform and the nature of the service system as a whole? What if Netflix began to offer user-generated content such as content shown on Facebook or Instagram? Each group that engages with a multi sided platform is characteristically different from the others, but what are the bounds (if any) of these differences? How might these differences be measured? Is there a limit to the sheer number of groups that make sense for a multi sided platform? To this end, what is the nature of value in multi sided platforms such as Netflix and how might this influence each group in the Netflix service system?

Second, it has been typically difficult to price services for a multi sided platform. Because multi sided platforms do not focus on ownership, they are more akin to the idea of incomplete products or servitization. With incomplete products, there is the idea of "freemium" in which the original product is given to customers for free; however, in order to fully enjoy the value of the original product, it is necessary to purchase add-ons and engage in microtransactions. With smart phone applications, this approach has become fundamental to enticing trial and sampling of new products and services. Relatedly, servitization refers to a shift from an emphasis on manufacturing to an emphasis on meeting customer needs through services, rather than products. An example of this would be offering an automobile service contract along with the purchase of a new automobile. Servitization entails looking beyond the purchase of a product to include the services, warranties, repairs, or upgrades that may transpire after an original product purchase. The process of preparing or transforming process for the "after-purchase" services is referred to as

servitization. Multi sided platforms often include long-term service features and value that can influence pricing.

In another illustration, massive multiplayer online games (MMOG) have begun to use the freemium model on mobile devices to engage and enhance their service systems. Traditionally limited to video game consoles, MMOGs have typically required the bandwidth of internet broadband services and the processing power of stand-alone video game consoles and such as Microsoft Xbox or Nintendo Playstation. However, in recent months, MMOGs such as Fortnite have become available on smart phones through cellular service in attempts to engage with players as they move throughout their days. The draw is the "freemium" app and players were quick to sample the new app; however, players became quickly discouraged when it became apparent that their progress would be hampered or slowed if they did not make additional purchases (i.e., microtransactions) of maps, weapons, or abilities. Furthermore, because the initial launch of the game required other players to already be playing the game (hence the massive multiplayer online game aspect), the game developers used artificially intelligent "bots" to "play" the game with first-movers to the multi sided platform. Unfortunately, as gamers became aware that bots comprised the majority of players in the service system, they became dissuaded from engaging with the freemium model of this multi sided platform. Kahn demonstrates that the perception of product completeness influences how viewers consumed the products. In this way, these service systems can be viewed as orienting around incomplete products.

Finally, the governance of a multi sided platform can greatly influence its success. In multi sided platforms, governance can range from no overarching control to complete and total control. In a multi sided platform that has no governance rules imparted by a central authority, the service system around that multi sided platform is implicitly coordinated by actors in the service system and the smaller parts organize the service system through consensualization. However, if a multi sided platform has a strong central authority, the smaller parts in the service system are enslaved; they must conform to the governance rules of the central authority. Amazon, a popular and successful multi sided platform at the time of writing, exerts quite strong authority on the service system that surrounds it and offers explicit governance rules. Like eBay, Amazon is an online marketplace that brings together buyers and sellers. However, Amazon integrates governance into their business model by encouraging behaviors that improve the service system overall; in other words, their pricing strategy encourages preferred behaviors from buyers (frequent purchases) and sellers (expedited shipping). Specifically, Amazon offers a flat monthly subscription fee to "prime" or preferred buyers which guarantees these buyers expedited 2-day shipping from "prime" preferred sellers. "Non-preferred" buyers and sellers are similarly encouraged to adhere to "good behaviors" through online reviews; however, the non-preferred groups are not required to behave in these ways and are thus subject to additional fees or steps in order to remain engaged in the service system. In a separate move, Amazon sought to further enhance engagement in its service system (i.e., govern the service system) with "dash buttons" that facilitate convenient and frequent engagement (i.e., purchases) by

removing the need to browse the web to place orders. A single button is pre-programmed with a single item purchase (e.g., laundry detergent) and wi-fi capability so that any item in the home can be mindlessly purchased with the simple push of a button. Similar attempts at governance include the smart-home assistant named "Alexa" which is a stand alone voice activated Amazon interface. By verbally announcing one's needs or demands to Alexa, a buyer immediately engages with Amazon and the Amazon service system.

## 11.4 The Future of Service Systems

Synergetics offers a way to think about the various types of service systems that are now converging around multi sided platforms. It frames the future of service systems around nonlinear and dynamic parameters. This is important because it is not sufficient to merely acknowledge the role of time and the continuous connection among actors in a service system. Rather, it is necessary to explicitly think about the complexity involved when actors—including customers, organizations, and stakeholders—influence one another in unpredictable ways that are not explained by traditional economic theory.

Multi sided platforms, like Amazon, Xbox, or Facebook, are value propositions that join actors together as service systems. These platforms are not the service system; rather they are platforms that bring disparate actors together as service systems. The logic that is imparted into the service system by each of these multi-sided platforms influences the parameters of the service system, along with its propagation and evolution. By clarifying the governance mechanisms of each platform, it can become clear how each of these multi sided platforms might evolve in response to the service system. Conversely, it can also become clear how the service system evolves in response to the multi sided platform. This is because the multi sided platform essentially operates as an unfinished or incomplete product until a critical mass in the service system surrounds it. The multi sided platform simply cannot function without sufficient size and heterogeneity in its service system. In this way, multi sided platforms contribute to servitization in ways that do more than entice engagement. They inform the very nature of the service system as a whole. They can impart logics into a service system. Furthermore, inherent in the fundamental design properties of multi sided platforms should be considerations such as governance, pricing, and network externalities.

Because the study of service systems is essentially the study of value, it is important to consider the influence of multi sided platforms on value co-creation. The value of multi sided platforms is that they connect service systems together, however it can be argued that multi sided platforms are not valuable by themselves. For these reasons, the variety of pivots or modes associated with multi sided platforms are important for service systems. In the Amazon example above, governance is implicit in the pricing strategy. The pricing strategy can change the entire logic of the service system. Furthermore, Amazon also governs its service system by

offering a variety of value propositions that enhance connectivity in the service system; these include a smart phone application, a website, a button, or a voice-activated assistant (Alexa). Each of these value propositions elicits different responses and varying levels of engagement from both buyers and sellers. They coalesce service systems while contributing to the dynamic relationships that comprise the Amazon service system.

Although the multi sided platform provides the initial consensualization needed to emerge a service system, synergetics proposes that value can be an active agent in further evolving service systems. Because value emerges from the multitude of relationships centered on a multi sided platform, value is a property of the system. As any of the components of the service system changes over time, so too does value. As a result, multi sided platforms can transform engagement in service systems. Engagement depends on the external connections and the internal dispositions of an actor (Chandler and Lusch 2015). Temporal connections join actors and services over time. An example of a temporal connection is the existence of an actor that moves forward through time, connecting past, present, and future. On the other hand, relational connections join actors to one another. An example of a relational connection is a group membership such as an alumni status or a family. In these ways, actors can be connected through time and also with one another. These are two properties of engagement.

Dispositions refer to an actor's psychological states that are oriented toward the past, present, and future. Each of these influences how actors appropriate their connections, which are neutral on their own. This occurs when actors engage in service systems; by doing so, they adapt connections from the past, for the present, and position themselves for a particular future. These psychological states can influence actors to continually refocus their connections with respect to their perceptions of the past. Similarly, psychological states may influence actors to assert meaningful connections in the present. And, finally, psychological states may influence actors to draw on their connections in particular ways to move toward a desired future.

All in all, each of these five properties of engagement relates to connections (temporal and relational) and dispositions (past, present, and future). These connections and dispositions comprise engagement. When they are aligned and synchronized, an actor is fully engaged. When they are synchronized, value co-creation emerges and an actor is more closely aligned with a service system. However, it is typically difficult for these properties to remain synchronized. These properties often fall out of alignment. Alignment of these five properties shifts over time with respect to the actor, the service system, and value.

These considerations coincide with the Cynefin framework, which proposes a decision-making framework based on complexity and systems theory (Snowden 2002). The Cynefin framework outlines "domains" for decision-making, namely simple, complicated, complex, chaotic, and disorder. These domains range, generally speaking, from situations in which cause and effect are clear and distinct, to situations in which cause and effect are ambiguous or emergent. The framework is based on the recognition that each manager or decision-maker has a different

perspective on a phenomenon and thus may manage the situation differently with respective to his or her individual perspective. The Cynefin framework can be useful for thinking about how actors engage with service systems.

Synergetics offers a way to think about this. The systemic principles of *critical distance* and *stability* relate to systems that are at *equilibrium*. At equilibrium, the five properties of engagement are aligned. Also, at equilibrium, a multi sided platform facilitates value co-creation. This is because critical distance facilitates the propensity of the service system to continue according to existing logics or orders. And, the multi sided platform generally dictates the logic or oder. Because this propensity is strong, the service system as a whole is resistant to perturbations or change.

However, in early transition phases of service systems, the systemic principles of *amplification* and *internal determination* describe, respectively, how fluctuations begin to randomly appear and how specific dynamics begin to arise from the unique parameters of a service system. In this way, a service system becomes unique and different from other service systems especially in response to external forces. If there is a multi sided platform at the center of the service system, it is typically a key component of these dynamics. These two systemic principles underscore that a system's unique, complex, and indeterminable response to an external force or jolt becomes apparent during the early transition phase. It becomes apparent through repetition of key systemic behaviors. Differences in these behaviors can help to reveal how disparate systems may respond differently to the same stimulus. At this stage, a multi sided platform can be at the center of multiple different service systems. A jolt in the multi sided platform, or a change in logic or repetition in the functionality of the multi sided platform, can send reverberations through to all the service systems that are connected to it. In this way, service system governance can be facilitated through a multi sided platform.

Next, *nonlinear loops* and *phase transitions* illustrate how *systemic evolution* takes hold in a service system. It is important to account for ways that service systems react back on themselves; synergetics outlines that this occurs through non-linear feedback loops, which serve as the pivots that shift logics and orders in service systems. As the loops ensue throughout the system, they can have smaller effects on certain components or they can have larger multiplier effects. In this way, service systems move from one state to another, and one equilibrium is replaced by a different equilibrium. It is important to note the multi sided platforms typically do not directly respond to changes because they are not typically the intended targets of changes. Instead, typically, relationships or actors in a service system change in response to an external force. In turn, then, the subsequent relationships and the other actors react or change in response to an external force, then influence the multi sided platform in some way.

Finally, *new systemic orders* are realized when the systemic principles of *symmetry breaking*, *limited predictability*, and *historical dependence* become evident. New orders are established when fluctuations have asserted different patterns, and other components of the service system become consensualized according to this new order parameter. With symmetry breaking, emergences evolve to become order

parameters that shape systemic components and properties. These emergences are unpredictable. That being said, limited predictability outlines that complete and comprehensive prediction of new systemic orders is not possible. Incidentally, the principle of historical dependence confirms that the past behaviors of a service system are the best predictors of the service system.

In all, as a system converges toward equilibrium and consensualizes its smaller components, the distinction among customers, employees, and machines become less clear. That is, customers, machines, and employees can all be viewed as value-creating actors who are engaging with a system. As this occurs, the distinctive boundaries of organizations will become less clear because platforms become the central focal point at which value-creating actors become organized. These smaller actors may no longer need the service(s) of traditional organizations. In turn, new ways of managing across projects and matrices will emerge.

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# Chapter 12
# Using Employees' Collective Intelligence for Service Innovation: Theory and Instruments

**Niels Feldmann, Hansjörg Fromm, Gerhard Satzger, and Ronny Schüritz**

**Abstract** In this chapter, we reflect on the potential and instruments for involving employees in service innovation processes. Based on a discussion of value co-creation scenarios in the context of service innovation, we conjecture that frontline employees of service providers can be powerful proxies for their customers. Thus, they might be a particularly valuable group to involve in service innovation endeavors. The quality of these proxies may increase with the depth of insights frontline employees can gain from their customers. Moreover, as the literature suggests, these employees can also cater for the strategic and cultural fit of service innovations to their organizations, to avoid a reported drawback of directly involving customers in the service innovation process. Hence, we first suggest leveraging the potential of large numbers of these employees through collective intelligence instruments and derive design recommendations for such approaches. In the second part of the chapter, we then introduce and compare four types of collective intelligence instruments that are currently used by companies to involve employees. We close by suggesting avenues for further research in this domain.

**Keywords** Collective intelligence · Wisdom of the crowd · Service innovation · Professional service firms · Crowdfunding · Enterprise crowdfunding · Idea markets · Participatory budgeting · Innovation communities

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**Annotation**: An earlier version of this chapter has appeared in the dissertation of Niels Feldmann (Feldmann 2018).

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_12

## 12.1 Introduction

In March 2016, IBM invited its employees from around the globe to participate in the IBM Cognitive Build campaign. This campaign was carried out through internal application of the crowdfunding mechanism as known from the internet, termed enterprise crowdfunding (ECF), and centered around designing and selecting solutions based on cognitive computing that IBM could offer to its customers. IBMers with ideas for such solutions would propose them on a crowdfunding platform and IBM employees, endowed with corporate money, could help to fund those projects they liked best. This implementation of ECF marks a highlight in a series of similar ECF campaigns at IBM since June 2012 (Feldmann and Gimpel 2016; Feldmann et al. 2014; Muller et al. 2013). Methodologically, ECF is one of the latest approaches to make use of collective intelligence (CI) for corporate innovation management.

The emergence of ECF at the service firm IBM does not come without reason. Currently, many companies from the service industry, in particular professional service firms, extend their traditional, purely human-delivered services to hybrid offerings. For this, they combine technical components developed in advance ("assets") with professional capabilities of their staff, as for instance in the case of asset-based consulting (Christensen et al. 2013). Examples include the development of consulting offerings related to cognitive computing or audit-oriented projects in the financial services industry (e.g. BearingPoint 2016). So far, for many professional service firms, creating new offerings has primarily happened *ad-hoc* (Gadrey and Gallouj 1998; Gallouj and Weinstein 1997), i.e. done by combining available knowledge and previously gained expertise, and emergent from customer projects (Toivonen and Tuominen 2009). Alternative innovation paths like *expertise-field innovation*, i.e. deliberately building up a field of expertise based on detected customer needs, and *formalization innovation* (Valtakoski and Järvi 2016), i.e. materializing services through scripted methods or customized tools, have been less pronounced (Gadrey and Gallouj 1998). In the light of more asset-based services, innovating new services at professional service firms is becoming a more project-oriented endeavor, as significant upfront investments in technical capabilities may be required. Hence, rebalancing the mentioned innovation paths and identifying new, effective options for expertise-field and formalization innovation seems to be advisable. One of such options that IBM started using with growing appetite is ECF. Meanwhile, other firms in the technology and service domains also started exploring it. At an abstract level, ECF is a novel mechanism that combines the two concepts *employee involvement* in (service) innovation and *collective intelligence* (CI). Although observed in the professional service firm domain, the application of these two general concepts, and the novel approach ECF in particular, may also be an inspiration for organizations in other industries.

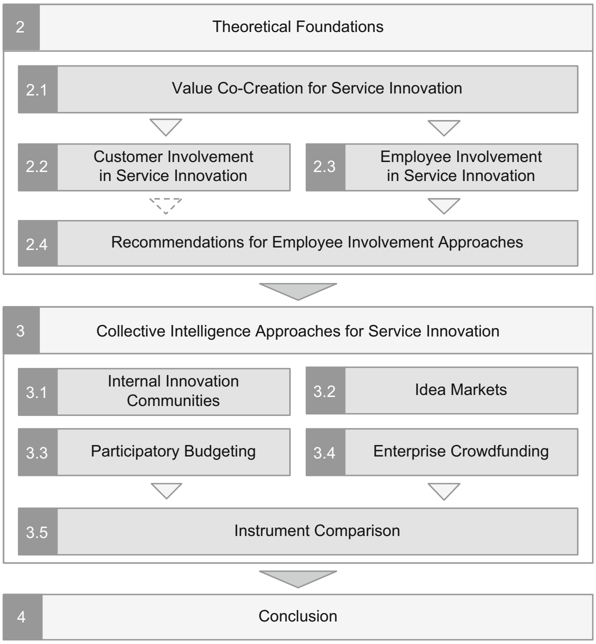
Apart from the practical relevance, the application of CI approaches for employee involvement in service innovation is also of academic interest. Lately, and for good reasons, new technological trends such as big data, the internet of things, or analytics

seem to be omnipresent in the service innovation literature. This stream of publications is also summarized under the term *technologist or assimilation perspective* (Coombs and Miles 2000; Drejer 2004). It refers to the role of technology for the development of (new) services (Breidbach et al. 2013; de Vries 2006). However, Schneider and Bowen (2010) point out a dominance of these topics in scholars' attention and suggest to also appropriately address the importance of individuals such as customers, employees, and managers as key contributors for service innovation endeavors. Accordingly, involving customers and further outsiders such as universities or business partners in service innovation processes gained increasing popularity under the umbrella concept of *open service innovation* (Chesbrough 2010, 2011; Chesbrough and Davies 2010). This stream of literature has expanded the understanding of new service development (Alam and Perry 2002; Edvardsson and Olsson 1996; Scheuing and Johnson 1989), which connects with the more general innovation process literature (Cooper and Kleinschmidt 1986).

However, involving external contributors in innovation processes does not come without challenges (Lichtenthaler 2011; van de Vrande et al. 2009; West and Gallagher 2006). Issues include intellectual property rights and motivating others to contribute without compensation. Hence, tapping the knowledge and capabilities of one's own employees, especially those with deep insights into the organization's customers, remains an interesting option. Approaches for doing this have unfortunately been underrepresented in the recent service innovation literature.

Overall, these considerations are in line with one of the central avenues for service innovation research outlined recently, namely finding new forms of integrating a customer perspective into the service innovation endeavors (Patricio et al. 2018). Motivated by this call for further research and the newly discovered ECF approach, we will focus on recent CI approaches that are facilitating employee involvement in service innovation. The structure of this chapter is as follows (Fig. 12.1): we start by using the pivotal concept of value co-creation as a lens to reflect on ways to incorporate a client perspective into service innovation processes (Sect. 12.2.1). Based on this, we then argue that frontline employees are a particularly valuable group of employees to involve in service innovation endeavors. We subsequently summarize literature on customer and employee involvement in service innovation (Sects. 12.2.2 and 12.2.3) and use it to derive recommendations for approaches that provide an opportunity to involve frontline employees in service innovation (Sect. 12.2.4). Given the easy access of a company to its own frontline employees, it seems reasonable to engage them in large numbers. Thus, in Sect. 12.3 we introduce the basics of CI and use the collective intelligence genome by Malone et al. (2010), to describe related mechanisms (Sects. 12.3.1–12.3.4) that facilitate (frontline) employee involvement in service innovation processes, such as idea markets or ECF. In Sect. 12.3.5 we compare the instruments and reflect on their fit with the defined recommendations. We close by summarizing the chapter and proposing avenues for future research (Sect. 12.4). In doing so, this chapter aims to emphasize the potential of involving large numbers of frontline employees in service innovation endeavors, capture the status quo of instruments that facilitate such an involvement, and suggest related research.

**Fig. 12.1** Chapter structure




## 12.2 Theoretical Foundations

### *12.2.1 A Value Co-Creation Perspective on Service Innovation*

Two concepts that are fundamental to service science are value co-creation and service systems. Service providers and customers form so called service systems in which they interact to achieve mutually beneficial outcomes, thus, they co-create value (Maglio and Spohrer 2013; Maglio and Spohrer 2008; Spohrer et al. 2007; Vargo and Lusch 2004). Conceptually, in value co-creation both sides, provider and customer, propose value to the corresponding partner, potentially considering interests of further stakeholders (e.g. authorities). For the actual co-creation, both sides contribute resources and grant each other access to these resources. Communication processes facilitate the co-creation act (Maglio and Spohrer 2013). Value co-creation is a general theoretical lens that should not be confused with the co-development process between two parties. However, as a general view, it can certainly be applied to describe real world processes such as the provision of services as well as the co-development of new products or services (Prahalad and Ramaswamy 2004; Vargo and Lusch 2004).

This may be illustrated by the example of a consultancy (service provider) providing consulting services to their customers while, at the same time, innovating their consulting offerings (Fig. 12.2). From the consultancy perspective three

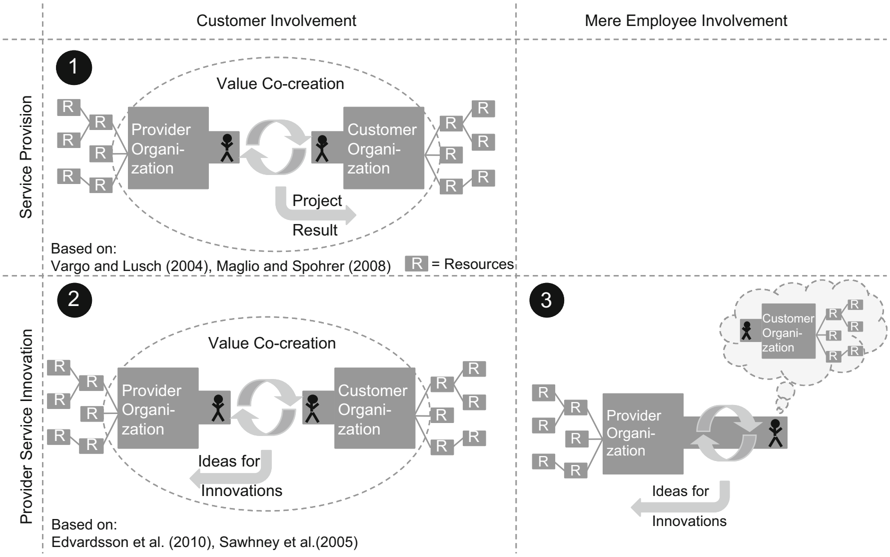



**Fig. 12.2** Value co-creation scenarios in the context of service innovation

interesting scenarios are subsequently outlined: In scenario 1, customer and provider personnel are involved in the *service provision* to the customer. In scenario 2, the consultancy's *service offerings* are innovated by involving (a limited amount of) own staff as well as several customer employees—a typical open innovation scenario. Finally, scenario 3 innovates the consultancy's service offerings by leveraging the market knowledge of a large number of their own consultants instead of customer employees. For the sake of completeness, it is noted that service provision without customer involvement is not meaningful.

In the service provision scenario, a consultancy supports a customer in a specific project situation such as improving processes or entering new markets (Fig. 12.2, scenario 1). For this, the consultancy provides resources such as staff, market knowledge, methods, and potentially supporting technology. Likewise, the customer contributes resources, e.g. employees, specific knowledge, and processes, to the project. Consultants and customer employees interact to solve the project challenge. Moreover, the two parties may use a project-specific communication process (e.g. communication tools and paths or even a specific vocabulary). The customer benefits directly from the resulting solution to the project challenge. In return, the consultancy receives financial compensation, acquires customer and domain specific knowledge, and methodological experience. Prior to project start, these benefits were either explicitly formulated or implicitly assumed as value propositions.

When it comes to developing new or improved service offerings, it is essential to ensure that these offerings are attractive to customers (Patricio et al. 2018). Hence, developing new offerings is about anticipating future service provision scenarios, i.e. value co-creation scenarios similar to the one addressed in scenario 1, that

"generate value for, to, and with the customers" (Patricio et al. 2018, p. 9). One way to ensure this is to involve customer employees in the services innovation process. This constitutes a second value co-creation scenario as outlined in Fig. 12.2, scenario 2. Thus, tacit knowledge, such as specific customer needs, can be captured directly from them and ideas for services they find appealing can be jointly derived (Chesbrough 2011). Moreover, if customer employees have already participated in the aforementioned service provision process (scenario 1), they will have an understanding of what ideas fit well with the provider. This is due to tacit knowledge about the provider's business, in our example insights into the strengths and weaknesses of the consultancy, that customer employees have built up during past service provision episodes. Hence, in this value co-creation scenario both parties integrate resources resulting in direct benefit to the provider (new offerings) and indirect, future benefit to the customer (novel and fitting services). We will cover the related literature and approaches in Sect. 12.2.2.

Conversely, during service provision as outlined above (Fig. 12.2, scenario 1), service provider employees also gain understanding of their customers, including their resources, value propositions they offer to their customers, constraints from stakeholders, and corporate culture and climate. In the consulting example, these insights may even be particularly rich, as consultants are trained in analyzing their customers. Consequently, involving one's own frontline employees into the service innovation process as proxies for their customers constitutes an indirect option to integrate the customer perspective (Fig. 12.2, scenario 3). This follows the notion of Schneider and Bowen (2010, p. 54) who suggest to "use employees as sources of external market research". While all employees may have a certain understanding of the market their company is addressing, frontline employees are empathic with their customers and know what changes are necessary internally to address customers' expectations (Schneider and Bowen 1995, p. 248).

From an innovation management perspective of the service provider, the involvement of a large number of their customers (scenario 2) and their frontline employees (scenario 3) is particularly interesting. Hence, we will subsequently discuss present literature addressing these options. We will see that customer involvement in service innovation bears certain risks and, thus, active engagement of frontline employees in service innovation endeavors gains attractiveness. Based on related literature we will then derive recommendations for more effectively involving (frontline) employees in service innovation endeavors.

### *12.2.2 Customer Involvement in Service Innovation*

The importance of using outside information for corporate innovation processes has long been emphasized by researchers and practitioners (Chesbrough 2006; Hippel 1978, 1988; IBM 2006). In the service innovation literature this aspect has been acknowledged in multiple publications ranging from more innovation process-oriented publications (Edvardsson et al. 2010; Prahalad and Ramaswamy 2004) to

papers on capability frameworks for service innovation, e.g. through the 'co-producing and orchestrating' capability in the framework of den Hertog et al. (2010). With the spread of the internet, new possibilities for involving customers in service innovation emerged. It became easier to reach customers and to interact with them. Thus, they got more actively involved rather than just passively observed or listened (Edvardsson et al. 2010; Sawhney et al. 2005). As mentioned, involving customers in innovation processes is one specific facet of the "joint creation of value by the company and the customer" (Prahalad and Ramaswamy 2004, p. 8), in short value co-creation.

In more recent papers, the term customer engagement has conceptually been discussed and connected with an organization's performance, including the innovation of services (Breidbach et al. 2014; Brodie et al. 2011). Building upon the idea of value co-creation, the term customer engagement was coined as "a psychological state that occurs by virtue of interactive, co-creative customer experiences with a focal agent/object (e.g., a brand) in focal service relationships" (Brodie et al. 2011, p. 260). Describing, understanding, and designing engagement platforms to foster and utilize interaction with customers became an interesting topic to study (Breidbach et al. 2014; Brodie et al. 2011; Sawhney et al. 2005). In this regard, engagement platforms were characterized as "physical or virtual touch points designed to provide structural support for the (. . .) co-creation of value between actors in a service ecosystem" (Breidbach et al. 2014, p. 594). Referring to the understanding of value co-creation in the context of providing goods or services, Breidbach et al. (2014) distinguish engagement platforms according to their *purpose* (transactional (t) vs. interactional (i)) and *state* (physical (p) vs. virtual (v)) into the categories *supplying* (t/p), *enabling* (t/v), *instrument* (i/t), and *operating* (i/v). This perspective and categorization of engagement platforms is relevant to a wide range of scenarios (e.g. purchase, consumption, or entertainment). Hence, the involvement of customers in a company's innovation management process is only one area of application of the more broadly defined term.

A similar categorization addressing the specifics of innovation management has been provided by Sawhney et al. (2005). They emphasize the collaborative aspect of engagement platforms and differentiate them along two dimensions: (1) the nature of the collaborations, i.e. reaching a broad audience vs. deep and rich interactions, and (2) their applicability for the various stages of an innovation process, i.e. ideation-oriented towards the front-end vs. rather implementation-oriented in the back-end. For the front-end, the authors identify approaches for idea generation which were fairly new at the time of publication, such as inviting customers to participate in online communities or contests to generate ideas. Moreover, they mention some mechanisms to gain feedback from customers on ideas, such as online surveys, polls, or "listening in", i.e. let users talk about an idea and capture what they say. On the back-end side, there is an emphasis on configuration and testing of products.

Another stream of literature, around open service innovation (Chesbrough 2010, 2011; Chesbrough and Davies 2010; Satzger and Neus 2010), focuses on the operating type of engagement platform according to Breidbach et al. (2014) and their application for innovation management in the sense of Sawhney et al. (2005)

and Edvardsson et al. (2010). Types of engagement platforms that have been addressed by this field of research include *idea contests* (Terwiesch and Xu 2008), *idea communities* (Fichter 2009; Füller et al. 2004) and *toolkits* (Piller and Walcher 2006). However, as West and Bogers (2014) point out, there has been an emphasis of open innovation research on the front-end (idea generation) of the innovation processes. Later phases of the innovation process such as integrating external inputs and commercialization received less attention. Presumably, this is because involving customers in later stages of the new service development process, such as evaluating, conceptualizing and implementing ideas is less widespread. Nevertheless, some crowdsourcing approaches entail activities covering all three phases (West and Bogers 2014).

While receiving first-hand information about customer needs and involving customers in the development of new services is intuitively beneficial, it does not come without challenges (Lichtenthaler 2011). Reported issues include organizational and cultural challenges—in particular in terms of integrating externally generated ideas, administrative hurdles, resource demand, property rights, and motivating others to contribute without compensation (van de Vrande et al. 2009; West and Gallagher 2006). Also, recent research indicates that assimilating customer knowledge and transforming it into service innovations endeavors has limitations (Storey and Larbig 2018). The study sketches a complex picture concerning the knowledge about customers that is recognized, that is needed to overcome inertia, and that can be processed.

### *12.2.3 Employee Involvement in Service Innovation*

Employees form another group of collaborators that companies may involve in their innovation management. In fact, its potential has been recognized for a long time. Employees have been perceived as a valuable source of ideas for process improvements (Bessant and Caffyn 1997), a provider of (market) information (Chen and Plott 2002; Schneider and Bowen 2010), and a contributor to innovation projects in general (IBM 2006). Consequently, firms offered employee suggestion schemes or dedicated innovation time such as 3M's 15% rule (Brand 1998) to tap this potential. Since the early 2000s, companies have increasingly started to leverage intranet solutions to tap the knowledge of their employees for innovation management. Examples include online employee suggestion systems, enterprise 2.0 solutions (McAfee 2006) such as blogs, wikis, forums, and some tools specifically geared to contribute to innovation management such as IBM's innovation jam (Bjelland and Wood 2008; Palmisano 2004). Overall, the latter approaches seemed to have an emphasis on information exchange and collective ideation rather than involvement of employees in later stages of the innovation process such as decision making or implementation (Zuchowski et al. 2016). In the service innovation literature, employee involvement in innovation management has been addressed occasionally across several decades. Among these papers, we want to highlight three more recent

ones that either focus on frontline employees or service domains where a large number of employees are frontline employees. As we have identified frontline employees as particularly valuable for employee involvement in service innovation processes, recommendations for how to involve them and seize their potential is of interest to us. Thus, the subsequent studies provide the basis for deriving such recommendations in the next section.

Leiponen (2006) investigates the influence of individually or collectively held tacit or explicit knowledge on service innovation performance in professional service firms. For this empirical study, she relies on survey data from 167 companies and 16 additional case studies. Besides other findings, her results emphasize the importance of collectively held tacit knowledge, i.e. "knowledge or skills residing in teams" (p. 247), for innovating new services. Explicitly held collective knowledge, i.e. codification of experiences or methods, also shows support for new services development, although to a weaker extent. Moreover, it strongly supports incremental, improvement oriented innovations. In this regard, the author recommends finding ways to facilitate the formation of teams and the emergence of collaboration routines within the team, as well as to incentivize team performance.

In another empirical study, Melton and Hartline (2010) investigate customer and frontline employee involvement in the new service development processes of firms from a broad range of industries such as financial services, healthcare, logistics, or education. The data analyzed comprises interviews and surveys gathered from 160 organizations. Regarding employee involvement, they find significant positive effects on sales performance when involving employees in the launch process of new services. In contrast to prior conceptual research they did not find employee involvement in earlier phases of the new service development process to be influential on subsequent success of a new service. As their findings were surprising, they suggest further research in this direction. It should be noted, that the authors' sample was very heterogeneous, hence, potential existing effects in various service industries may have been canceled out or diluted.

A recent study by Valtakoski and Järvi (2016) addresses the specifics of employee involvement in service innovation in knowledge-intensive business services. They investigate longitudinal data from two polar cases, one successful and one unsuccessful project, applying a qualitative, inductive case study approach. With regard to types of service innovation their study focuses on formalization innovation (called service productization by the authors), i.e. services that are codified (as methods) or embedded in software. From previous literature, they summarize known antecedents of successful service innovation in general, including the presence of formal innovation processes, managerial support, participation of frontline employees and cross-unit collaboration. However, they also derive specifics of knowledge-intensive business services from extant research, namely (1) employees' resistance to codify their knowledge due to fears of losing status, (2) a general opposition to strategic change, as well as (3) group conflicts hampering the internal spread of innovations. Based on these factors, the authors challenge the effectiveness of the known antecedents through the two case studies. And indeed, they find employee participation and cross-unit collaboration in general not to be sufficient

for successful service innovation in knowledge-intensive business service firms. They suggest fostering knowledge sharing on an individual level and to make cross-unit collaboration more attractive for organizational units. In terms of knowledge sharing, employees' personal objectives and the innovation project's goals should be aligned. Moreover, a culture of trust should be maintained. Regarding cross-unit collaboration the authors recommend a common language to reduce communication barriers as well as active conflict resolution between involved units.

### *12.2.4 Recommendations for Employee Involvement Approaches*

We conclude this section on theoretical foundations by summarizing recommendations that may contribute to selecting or improving mechanisms facilitating the involvement of large numbers of frontline employees in service innovation. For this, we primarily build upon the literature discussed in the previous section.

Involving customers and further stakeholders from outside into an organization's service innovation processes gained a lot of attention in the past decades but does not come without challenges (Lichtenthaler 2011). Most notably, organizational and cultural issues with regard to matching ideas to the provider organization remain (van de Vrande et al. 2009; West and Gallagher 2006), as customers' understanding of the provider organization is arguably too superficial. Hence, customer involvement is valuable but not sufficient for successful service innovation processes.

Based on our deliberation on value co-creation scenarios, we conjecture that frontline employees of service providers can be used as proxies for their customers in their own firms' service innovation processes (Schneider and Bowen 2010). This particularly applies to service types that require a deep customer understanding and involve provider employees with strong observational, analytical and creative capabilities. Moreover, involving frontline employees in service innovation caters for an internal fit (Schneider and Bowen 1995, p. 247) of ideas, causes less concerns with IP rights, confidentiality, and loyalty, and contributes to an effective launch of a new service (Melton and Hartline 2010). Hence, it provides an alternative to involving customer employees in the service innovation process of a service provider, in case the downsides of involving external parties as discussed above weigh in too much. Thus, frontline employees could potentially replace customers. At least, they are valuable for complementing the innovation process. Thus, designing mechanisms in a way to leverage this potential is important.

The subsequent recommendations may help to effectively further the mechanisms for involving employees in general, and frontline employees in particular, into service innovation (subsequently called 'the mechanisms'):

**Recommendation 1.—Cross-Unit Collaboration:** *The mechanisms should facilitate and simplify cross-unit collaboration between participants.*

Cross-unit collaboration has been identified as an antecedent of service innovation success by several authors (Leiponen 2006; Valtakoski and Järvi 2016). Moreover, Valtakoski and Järvi (2016) emphasize the necessity to simplify cross-unit collaboration through the introduction of a terminology that all sides can understand and to actively resolve conflicts between units. Hence, we suggest to choose mechanisms where members of different units can discover common interests and collaborate with one another spontaneously and voluntarily.

**Recommendation 2.—Individual Incentives:** *Opportunities for improving one's own status should encourage participating individuals to contribute to service innovation.*

Similar to the attractiveness for units and teams, participating employees need to be encouraged to share their valuable knowledge. Valtakoski and Järvi (2016, p. 372) state that "knowledge is also a source of status for (...) employees, who are likely to resist attempts to (...) codify this knowledge, as this would undermine their bargaining position." Thus, novel approaches that strive for employee involvement shall offer ways to maintain or expand personal status through sharing individually held tacit knowledge.

**Recommendation 3.—Community Empowerment:** *Finding other like-minded participants, forming communities around shared interests, and collaborating within these communities is conducive to service innovation and should be furthered by the mechanisms.*

Tacit collective knowledge in the context of formation of and collaboration in teams was found to be influential for service innovation success, in particular new service development (Leiponen 2006). When individuals, potentially from different units, find a common topic intriguing, they are intrinsically motivated to mutually learn from each other and advance the topic—thus, form communities. Consequently, we suggest supporting community building through features that allow finding themes of interest and like-minded fellows. Also, features that support an ongoing exchange of thoughts may help to stabilize the community and allow the formation of community routines, as Leiponen (2006) calls it.

**Recommendation 4.—Customer-Employee Mix:** *Tapping and integrating the knowledge and ideas from both sides, customers and frontline employees, through simultaneous involvement may be facilitated by the mechanisms.*

In Sect. 12.2.2 we found customer involvement in the service innovation process to be a potentially powerful option as they are the original voice of the market. However, challenges with regard to integrating and commercializing the customers' ideas remain. Conversely, frontline employees of service providers may be attractive proxies for their customers, hence, are an *indirect* voice of the market. However, they excel in knowing what fits well to their organization, strategically, operationally, and culturally (Schneider and Bowen 2010). Also, as they need to operationalize these ideas internally, they are valuable contributors for designing the successful market launches of service innovations (Melton and Hartline 2010). Thus, we suggest that novel innovation approaches should simultaneously involve customers and employees in the service innovation process and facilitate interaction

among them. This recommendation is also supported by a recent study on co-design (Trischler et al. 2018) finding that mixed teams of customers and employees develop ideas of higher degrees of user benefit and novelty than teams consisting of customers or internal employees only.

In the next section, we introduce a series of CI approaches primarily geared towards involving employees in (service) innovation processes which gained awareness in recent years. As ECF introduced at the beginning of this chapter is the latest and least known approach, we will outline it in more depth. Reflecting on these CI mechanisms fit with the recommendations outlined in this section concludes the section.

## 12.3 Collective Intelligence Approaches for Service Innovation

For leveraging the potential of large numbers of people two paradigms have been dominant in the past two decades, the *wisdom of crowds* (Surowiecki 2005) and *collective intelligence* (CI) (Leimeister 2010; Levy 1999; Malone et al. 2010). While these two terms are often used interchangeably, their original definitions vary.

Surowiecki (2005, p. xiii) states that "under the right circumstances, groups are remarkably intelligent, and are often smarter than the smartest people in them." He calls this the wisdom of crowds (p. xiv) and specifies "the right circumstances" by four conditions (p. 10). Firstly, he emphasizes the diversity of opinion, i.e. people representing a broad variety of perspectives. Secondly, he requests independence of the individuals within the group. Hence, no mutual influence of each other's opinions should occur. Thirdly, he demands a decentralization regarding group members' specialization and knowledge. Finally, he requires the presence of an aggregation mechanism for combining the various opinions. The underlying idea of Surowiecki's wisdom of crowds concept is that all group members have true and false information about a given topic. If the groups are large enough and satisfy the conditions above, incorrect information of the individuals is balanced out and true information remains. Simmons et al. (2011) add two further conditions to make wisdom of crowd approaches meaningful. They emphasize that there needs to be relevant knowledge present within at least part of the crowd. Moreover, group members shall not be systematically biased. If the whole crowd is biased towards one side, no balancing can take place. In a 1907 article in the scientific journal "Nature", Galton (1907) already reports an example that demonstrated that a wisdom of crowds, as characterized by Surowiecki (2005), exists.

In his seminal book, Levy (1999, p. 13) defines collective intelligence as "a form of universally distributed intelligence, constantly enhanced, coordinated in real time, and resulting in the effective mobilization of skills." Subsequently, he calls for systems providing "the means to coordinate (. . .) interactions". Woolley et al. (2010) published an experiment demonstrating that collective intelligence also exists in terms of groups of individuals working cooperatively on broad set of tasks.

Jenkins (2006) discusses the two concepts and concludes that Levy's perspective on CI is one of *interaction and knowledge sharing* rather than Surowiecki's view of independently kept individuals coordinated through an *aggregation mechanism*.

To add a more recent perspective, Malone et al. (2009, p. 2) provide a definition that covers but also goes beyond the two previously outlined perspectives. They define CI "very broadly as groups of individuals doing things collectively that seem intelligent" and provide an empirically developed framework (Malone et al. 2009, 2010), called the *collective intelligence genome*. This allows the categorization of the various CI implementations along four dimensions (Malone et al. 2009), each of them including a series of sub-dimensions, termed genes:

1. *What* shall be done? This distinguishes between the two tasks *Create* and *Decide*.
2. *How* does the mechanism work? More specifically, they combine the question whether individuals contribute *independently* or *dependently* (see discussion on difference between Surowiecki and Levy) with the task to be solved, i.e. to create or to decide. From this, four genes derive: *Collection* (create—independent), *Individual Decision* (decide—independent), *Collaboration* (create—dependent), and *Group Decision* (decision—dependent).
3. *Who* is supposed to act, i.e. does some sort of *Hierarchy* assign tasks to people/groups or do members of a *Crowd* act on their own?
4. *Why* would these people participate? *Money* is the gene representing monetary incentives. *Love* summarizes motivations gained from enjoying the activity, socializing with others, or contributing to a cause. *Glory* stands for taking motivation from the recognition received by others.

The various approaches for tapping collective intelligence have also been summarized under several other umbrella terms. One such prominent umbrella terms is *crowdsourcing* (Howe 2006a), which Howe (2006b) defines as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call." The phrase "performed by employees and outsourcing it to an undefined (...) network of people" can be interpreted differently. The question is whether 'outsourcing' refers only to a "network of people" outside of the organization in question or includes people from inside as well. Consistent with the crowdsourcing understanding of Zuchowski et al. (2016), we apply the latter interpretation, i.e. use 'outsourcing' to refer to people outside of the group which usually performs a task, no matter if inside or outside of the organization. Thus, in a company-internal setting, inviting a larger group of employees to collectively draw a decision would fall into the crowdsourcing and collective intelligence cluster if the decision-making task would have been covered by managers otherwise.

Previous publications have provided overviews and categorizations of crowdsourcing approaches that were present at the given point in time (Bonabeau 2009; Geiger et al. 2012; Leimeister 2010). Zuchowski et al. (2016) provide a corresponding overview of crowdsourcing approaches that are applied inside organizations. They summarize these approaches under the term internal crowdsourcing, which they define as "an IT-enabled group activity based on an open call for

participation in an enterprise" (p. 168). Accordingly, the initially outlined enterprise crowdfunding (ECF) is a sub-category of internal crowdsourcing.

As supporting innovation is often a side goal for implementing crowdsourcing in organizations, few of the mechanisms from these fields are explicitly designed to contribute to innovation processes. Of those that are geared in this direction, mechanisms for capturing ideas internally seem to be the most widespread (Cooper and Edgett 2008). However, overall, the mechanisms seem to exhibit limited effectiveness due to poor implementation concepts (Cooper and Edgett 2008) and to be less suited for idea evaluation (Bonabeau 2009). Considering these shortcomings, we subsequently introduce a selection of more recent mechanisms that are aiming at improving innovation management by involving employees and, at least, include idea evaluation functionality. Amongst these, we will pay most attention to enterprise crowdfunding (ECF), the latest of the selected approaches. We will position them in the CI genome and discuss their overlaps and differences.

### *12.3.1 Internal Innovation Communities*

We start our overview with mechanisms that gained popularity in the mid-2000s, at the time when the above-mentioned terms were coined. Companies took inspiration from open innovation (Chesbrough 2006) mechanisms, e.g. innovation contests (Terwiesch and Xu 2008) or innovation communities (Bayus 2013; Fichter 2009; Füller et al. 2004), and mirrored and adjusted them for internally involving employees in innovation management endeavors (Bonabeau 2009; Cooper and Edgett 2008; Simula and Vuori 2012). Although widely used, the various mechanisms seem to be fairly similar (Hrastinski et al. 2010). Simula and Vuori (2012, p. 8) state that "at best, internal crowdsourcing can take the form of 'idea jams,' as promoted by IBM." Thus, as a representative of this type of mechanism, we briefly outline innovation jams (https://www.collaborationjam.com), a mechanism that involves both innovation community and innovation contest.

An innovation jam is an open and parallel forum that is organized as an online event geared towards fostering collaboration and innovation (Bjelland and Wood 2008; IBM 2017). Introduced as early as 2001, innovation jams are still in use at IBM and other companies (Ready 2015). This mechanism has been applied for a broad variety of purposes including the formulation of company values (Palmisano 2004; Ready 2015) or generating ideas for new products and services (Bjelland and Wood 2008; Helander et al. 2007). In brief, IBM invites its employees (and potentially further participants) to an online discussion of selected, predefined topics for (mostly) 72 h, allowing employees worldwide to contribute their perspectives on the subject matter and to jointly generate related ideas for innovation projects. These discussions take place on a platform that offers one forum for each of the topics. Within each forum, participants can open threads for subtopics and submit posts to them (Helander et al. 2007). Each forum is facilitated by a central team which is supported by real-time analyses of the ongoing discussions. Moreover,

complementary features such as quick polls or public posts drawing people's attention to "hot topics" are provided. After the actual jam, a team of experts embarks on combined quantitative and qualitative analyses to distill the jam findings. Context-dependent, jams can be conducted sequentially shifting the participants' focus from run to run, e.g. generating mutual understanding of a topic, idea generation, or conceptualization of ideas. In terms of decision support, voting elements (e.g. giving stars to certain posts) are present to capture the participants' appraisal of an idea. However, facilitating decision-making is not central to jams. If the innovation jam is used for an idea contest, a board of experts evaluates ideas that were submitted by individuals or jointly developed by the community. Generally, both idea evaluation mechanisms (star rating by crowd as well as dedicated decision boards) are common in many other similarly designed idea management approaches (Hrastinski et al. 2010). Nevertheless, the character of innovation jams is clearly that of peer discussions that result in joint outcomes rather than that of a decision-making instrument.

With regard to the CI genome (Malone et al. 2010) innovation communities such as innovation jams can be categorized as follows:

**What:**

1. **Create.** The focus of idea communities such as the innovation jam lies in joint deliberation and creation.
2. **Decide.** Functionality for decision-making (polls, votes) is quite limited and often used to guide the general discussion or subsequent decision-making by experts or managers. Hence, it is not at the center of the mechanism but can play a role.

**How: Dependent.** Jams and other innovation communities are highly interactive discussions. Thus, in combination with the create gene, the collaborate gene applies. In terms of decision making the voting or averaging sub-gene of the group-decision gene apply. While individual votes are taken independently, all participants provide a joint recommendation for a decision. Malone et al. (2010, p. 30) characterizes this as a group decision.

**Who:**

1. **Crowd.** Communities (jams) are offered by the management but participation is voluntary and adoption of roles by individuals happens dynamically, thus, it belongs to the crowd gene (Malone et al. 2010, p. 26).
2. **Hierarchy.** The final decision upon the proposed ideas is taken by established decision-makers who take the votes from the innovation community into account. Hence, the hierarchy gene also applies to the decide action in innovation communities.

**Why: Love.** People neither receive direct incentives nor is the mechanism designed to provide glory to individuals for their contributions. For the latter, the number of posts is too high, and summaries of the discussion are often posted under the name of the facilitator, hence, not associated with the original poster. Thus, "intrinsic enjoyment" or "contributing to a cause" remain as motivators (Malone

et al. 2010, p. 27), i.e. the love gene applies. In company internal settings it is conceivable that employees may not participate in jams completely voluntarily but are more or less pushed by the management to do so. In this case, the money gene would apply. However, this is speculative.

### *12.3.2 Idea Markets*

Another set of mechanisms for capturing crowd wisdom that is mentioned in Surowiecki (2005) are market mechanisms as known from the stock market. One of these mechanisms are prediction markets. Their main purpose is to aggregate dispersed information from a large audience and forecast the results of political or sports events, economic indicators, corporate valuations, revenues and the like (Arrow et al. 2008; Bennouri et al. 2011; Gillen et al. 2012; Teschner 2012; Wolfers and Zitzewitz 2004). Depending on their configuration, markets of this kind are realized as prediction markets, exhibiting similarities to stock markets (Arrow et al. 2008), or betting markets (Plott et al. 2003), inspired by betting at horse races. According to Arrow et al. (2008, p. 877), "Prediction markets are forums for trading contracts that yield payments based on the outcome of uncertain events". They have shown high prediction precision in many fields, e.g. forecasting election outcomes. Therefore, they have been applied to a broad set of situations, for instance in the defense and healthcare industries, and have often surpassed other prediction tools (Wolfers and Zitzewitz 2006).

In academia and practice, prediction markets are increasingly applied to idea assessment and, thus, often called idea markets (Kamp and Koen 2009; Lavoie 2009; Soukhoroukova et al. 2012; Spears et al. 2009; Stathel 2010). The basic setup works as follows (Kamp and Koen 2009; Soukhoroukova et al. 2012): Each idea is represented by a security, e.g. shares, which are introduced to the market via a sort of Initial Public Offering (IPO) with predetermined prices. Market participants (e.g. employees) receive a certain amount of a virtual currency, so they can start buying these idea shares. If the number of shares sold for a specific idea exceeds a predefined threshold at the end of the IPO phase, the idea passed a first gate. Otherwise it is taken off the market. Subsequently, the securities are traded amongst the participants—much like in a stock market—and the appreciation or depreciation of an idea can be read off the security's market price at any time. This provides orientation to decision makers for corresponding approval and funding decisions.

Betting markets are related to prediction markets, but participants are placing bets instead of buying shares (Plott et al. 2003). One major difference between betting markets and prediction markets lies in the number of rounds the market comprises. While prediction markets typically are designed as a two-step approach, i.e. IPO and subsequent trading, betting markets consist of a single step.

So far, idea markets have been implemented at various corporations in different geographies, e.g. EnBW (Stathel 2010) or GE (Ottaviani 2009; Spears et al. 2009). While these market mechanisms do provide some clear advantages for information

aggregation, such as the potential to involve large numbers of individuals, quick results, and continuously updated preferences of the participants, they also have downsides. Graefe and Armstrong (2011) report on feedback from participants in experiments, finding that prediction markets were not very popular compared to more traditional approaches. Moreover, they provide opportunities for manipulative behavior (Othman and Sandholm 2010).

With regard to the CI genome (Malone et al. 2010) idea markets in their pure form can be categorized as follows:

**What:**

1. **Create.** The idea portfolio for an idea market needs to be built up upfront. It is a design decision whether this is done centrally through dedicated teams, units etc., i.e. the portfolio is simply provided, or if the crowd gets involved in this task. Hence, there is an element of creation, or better idea pooling, facet present as well. However, it is not a core element of the mechanism itself.
2. **Decide.** The predominant function of idea markets is to evaluate ideas by trading them. Consequently, participants constantly decide whether to buy or sell shares of an idea. This leads to information that contributes to drawing decisions upon the realization of the ideas in questions by official decision makers.

**How:**

1. **Dependent.** In idea markets, the actions of traders are influenced by the market mechanism as the share prices of ideas are visible to them. Thus, Malone et al. (2010, p. 30) assign them to the group decision (decide-dependent) gene which characterizes situations where "inputs from members of the crowd are assembled to generate a decision that holds for the group as a whole." In fact, they introduce a separate prediction market sub-gene within the group decision gene.
2. **Independent.** Idea markets only pool ideas from the crowd (in case the crowd is involved in the create task). Proposers are independent from others what to submit, although, their proposals may be inspired by others. Malone et al. (2010) categorizes collection as an independent act.

**Who:**

1. **Crowd.** Markets are designed to tap information from a crowd. There is no tailoring of activities, participation is voluntary, and adoption of roles takes place dynamically.
2. **Hierarchy.** As mentioned, the portfolio of projects to decide upon may also be provided centrally. Moreover, the final decision is also taken by established decision-makers who take the course of the idea shares into consideration. Hence, the hierarchy gene also applies to both actions in idea markets.

**Why:**

1. **Money and Love.** Traders in prediction markets are incentivized by a reward they get for the value of their portfolio at the end of the trading phase (Ottaviani 2009). Thus, the money gene applies to them. In a company-internal context with

traders being employees, we can assume that there is also an aspect of love in terms of “contributing to a cause” or even “intrinsic enjoyment” (Malone et al. 2010, p. 27).

2. **Glory.** People proposing ideas to an idea market receive recognition for it and, in case the idea performs well, funding and glory for the project (Ottaviani 2009).

### *12.3.3 Participatory Budgeting*

Participatory Budgeting (PB) is an umbrella term for mechanisms that aim to “allow (. . .) the participation of non-elected citizens in the conception and/or allocation of public finances” (Sintomer et al. 2008, p. 168). Its application has started in Brazil in 1989 (de Sousa Santos 1998) and has been applied across the globe by many municipalities since (Cabannes 2004). Given the broad diversity of PB implementations a universal definition of the term is hardly possible (Sintomer et al. 2008). Instead, the authors suggest to specify the notion of participation in public finances along the criteria (1) budgetary dimension, (2) involvement of a formal decision authority, (3) securing a repeated endeavor (not one-off event), (4) form of public deliberation, and (5) accountability for the outcome. Moreover, to provide orientation, Sintomer et al. (2008) outline a typology of European PB implementations. They differentiate six types of PB ranging from almost autonomous budget allocation by the members of a community to rather consultative approaches where citizens are only questioned about their opinion on a variety of endeavors. Amongst others, typical dimensions of variance of the approaches include (also compare Cabannes 2004, pp. 28–29) the level at which PB takes place (e.g. neighborhood vs. city level), the type of subject matter (e.g. prioritizing concrete projects vs. overarching themes), the degree of concreteness (e.g. budget allocation vs. general voice), or the level of involved individuals (e.g. the breadth of citizens vs. elected delegates).

However, the aim of providing communities a level of decision-making power related to subjects affecting themselves applies, while final decisions are left with a legally authorized body. Directly mirroring this concept for use in companies means, to distribute annual budget to specific national branches and/or business units. The members of the respective units would then participate in decision-making upon the allocation of the budget while final decision remains with the organization’s management.

The concept of PB has also been transferred to innovation management in companies. One example, that is in fact directly taken from the participatory budgeting endeavor in the city of San Jose, CA (Greeley 2012), is Conteneo’s portfolio prioritization game Buy a Feature (Hohmann 2007, 2014). Its application in the context of idea evaluation in innovation management is described as follows (Feldmann and Kohler 2015; Hohmann 2016): Employees form groups in which they are asked to suggest which ideas out of a given portfolio to pursue. For this, a list of ideas including description and price tags is provided and every player is

endowed with a certain budget. The participants then engage in a facilitated group discussion where they make their decision jointly and consensus-oriented. According to anecdotal evidence of the provider, the mechanism is rather designed for smaller groups and small portfolios. However, involving larger crowds can be achieved by setting up a tournament mode, i.e. play rounds in groups with portfolio subset, aggregate results, and then play follow-on rounds with a reduced portfolio.

In terms of the CI genome (Malone et al. 2010) PB in its pure form can be categorized as follows:

**What:**

1. **Create.** Creating proposals or solutions is not the focus of PB. However, during the discussions about budget allocation, priorities and potential ideas for improvement may emerge and be communicated to the official bodies and decision makers. However, this is not a dedicated idea generation activity as discussed in the context of the fuzzy front end of innovation.
2. **Decide.** The predominant function of PB is the evaluation of suggestions and the allocation of budgets. Nevertheless, these decisions have only suggestive character, as they have to be approved by an official body.

**How: Dependent.** Irrespective of the chosen approach, consensus-oriented group decisions are a cornerstone of PB. Other than in the idea market case, interaction goes far beyond coordinated actions through a market mechanism. PB is rather characterized by intense mutual deliberation. Hence, the dependent gene also applies to the creation task, if it takes place.

**Who:**

1. **Crowd or Hierarchy.** Depending on the PB setup either a grassroots audience such as the citizen of a community (crowd approach), or representatives such as elected delegates or union leaders (hierarchy approach) are invited to participate. Hence, whether the criterion of Malone et al. (2010, p. 26) applies—"activities can be undertaken by anyone in a large group who chooses to do so, without being assigned by someone in a position of authority"—depends on the way participation works. Correspondingly, this affects the create as well as decide activities in the mechanism.
2. **Hierarchy.** Besides the activities of the participants in PB, the portfolio of projects to decide upon is often provided by a hierarchical body. Moreover, the final decision is also taken by this body or established decision-makers. Hence, the hierarchy gene always applies to both actions in PB.

**Why: Money or Love.** In general, people participate in PB to represent their interests. This may be for their personal benefit or well-being (money) or to support a special matter (love). These motivators apply to both, decision-making and creation (as far as it takes place in PB).

### *12.3.4 Enterprise Crowdfunding*

As stated in Sect. 12.3.1, many internal crowdsourcing mechanisms are mirrored approaches known from the internet that got adopted for internal use in an organization. Schwienbacher and Larralde (2010) view crowdfunding (CF) as a (recent) type of crowdsourcing, and Mollick (2014, p. 2) defines it as "the efforts by entrepreneurial individuals and groups (. . .) to fund their ventures by drawing on relatively small contributions from a relatively large number of individuals using the internet." Consequently, enterprise crowdfunding (ECF) refers to mirroring the concept of CF for an organization-internal application. Before defining and conceptually outlining ECF we briefly shed some light on its original template CF.

#### 12.3.4.1 Crowdfunding Foundations

According to Hemer (2011, p. 2) CF via the internet emerged from novel types of fundraising campaigns in the music business starting in the late 1990s (Spellman 2008, e.g.) or later in politics, e.g. the 2008 Obama campaign.

Initially, as seen in these cases, single requesters called the crowd for financial support via their own websites. From the late 2000s onwards, CF platforms appeared on the internet, functioning as intermediaries between those seeking money and a potential crowd of investors. These internet platforms provide social network capabilities and therefore facilitate reaching out to the crowd and engaging with them at an unprecedented level; this constitutes the novelty of crowdfunding (Hemer 2011).

While artists and politicians were among the first users, CF quickly became popular with a broad variety of users. Entrepreneurs, companies, and many more discovered CF as a funding source for projects (Burtch et al. 2014; Schwienbacher and Larralde 2010), and thus many CF variations emerged. An early but widely used categorization distinguishes them by the type of return an investor would expect (Bradford 2012, pp. 15–21): Equity CF became popular with startup companies as a means to raise equity(-like funds) (Ahlers et al. 2015). Lending-based and donation-based CF got adopted for charitable situations (Bradford 2012). The major CF approach, however, is reward-based CF where investors receive a (non-monetary) return for their contributions (e.g. Kickstarter.com). Sometimes these rewards also constitute the form of product pre-sales (Bradford 2012). The latter format has been applied by users ranging from entrepreneurs to artists. Moreover, following the notion of participatory budgeting, CF has been used by municipalities to fund small public goods. This CF variation has been termed civic CF (Davies 2014; Stiver et al. 2015).

Although first scientific papers on CF already appeared about a decade ago (e.g. Harms 2007; Kappel 2009), CF-related literature was still called 'nascent' in 2014 (Belleflamme et al. 2014). In recent years, however, crowdfunding has attracted the attention of researchers from various disciplines such as law (Bradford 2012), finance (Belleflamme et al. 2014), entrepreneurship (Ahlers et al. 2015),

experimental economics (Wash and Solomon 2014), or human-computer interaction (Hui et al. 2014). Studies have focused on specific types of crowdfunding (Ahlers et al. 2015), application in specific industries (Kappel 2009), taxonomy development (Haas et al. 2014), motivations for participation (Gerber et al. 2012), project support dynamics (Kuppuswamy and Bayus 2015), gender specific behavior (Marom et al. 2016), use of fake information (Wessel et al. 2016), or determinants of funding success (Agrawal et al. 2015; Mitra and Gilbert 2014; Mollick 2014; Zvilichovsky et al. 2013).

#### 12.3.4.2 Definition and Process of Enterprise Crowdfunding

Applying crowdfunding within an organization, i.e. enterprise crowdfunding (ECF), is a fairly new idea. Vogel and Fischler-Strasak (2014), mention the internal application of CF as a side note and see opportunities for facilitating inter-departmental funding of ideas. A first implementation within a company was conducted by an IBM research center in 2012 (Muller et al. 2013). In their seminal paper, Muller et al. (2013) provide an analytical description of this first experiment. They report encouraging results such as high levels of participation, extensive inter-departmental collaboration, and the forming of new communities of interest. While ECF is derived from CF as known from the internet, it exhibits some notable differences. Providing an overview of a typical ECF process as conducted by IBM, who spearheaded ECF usage, and deriving a definition from it may help to reveal these differences (Feldmann and Gimpel 2016; Feldmann et al. 2013, 2014; Muller et al. 2013).

Accounting for a smaller audience inside an organization compared to CF on the internet, ECF is mostly organized in campaigns of roughly a month in length, subsequently called runs. They often center around a strategically chosen theme. Employees submit proposals for innovation projects to an internal crowdfunding site and ask for contributions from colleagues. Like CF on the internet, proposals in ECF comprise of a description, potentially enriched by media, and a funding target. Before making these proposals public, a vetting team reviews them for legality and potential redundancy. Then, all employees participating as investors (also called backers) are endowed with an equal share of the budget reserved for the specific run, also called the wallet. Thus, all members of the respective internal crowd become trustees of their company and are asked to invest company money on the published proposals.

However, they don't need to spend all money, in case proposals are not compelling enough. In addition to financial contributions, some implementations provide investors the possibility to volunteer for helping to implement a proposal in case it is successfully funded. Throughout the whole run, proposers and other participants can communicate with each other in the comments and updates sections of each proposal. ECF, as implemented currently, applies an all-or-nothing policy, meaning that proposals are only implemented if the target is fully met. Unused budget is returned to the organization and is reserved for the next run. Funded proposals do not need

further management approval, i.e. the funding decision of the crowd is final. The resulting projects get implemented by the proposer or, in case of larger projects, the organization with the proposer staying involved as a mentor.

Building upon this process overview and the previously mentioned definitions of CF (Mollick 2014) and internal crowdsourcing (Zuchowski et al. 2016) we define ECF as follows:

> Definition. *Enterprise crowdfunding (ECF) is an enterprise's application of an intranet-based crowdfunding mechanism for engaging a wide audience of its employees in generating, maturing, evaluating, and funding ideas for internal innovation projects through an open call for participation.*

In terms of differences between CF and ECF three major cornerstones stick out: (1) CF platforms on the internet are primarily intermediaries between two sides. The organization providing the platform aims at ensuring a vibrant market place in order to profit from the funding of projects through a commission (see Agrawal et al., 2014, p. 74). ECF in contrast is used by the management of an organization for portfolio outcome optimization with a strategic intent in mind. Hence, it centers around deliberately chosen themes. (2) Other than on the internet, the audience involved in ECF is comparably small and predetermined. Consequently, ECF is organized in runs to maintain critical mass. (3) The endowment of company budget to participants results from a company-internal setting. Hence, the overall budget and its pattern of allocation to participants are conscious decisions.

IBM has conducted a series of ECF runs in different settings. Two runs are remarkable in terms of size and impact: In 2014, a run centering around mobile apps for IBMers was conducted. Employees were asked to submit corresponding proposals to IBM's ECF site, named ifundIT. In parallel, 2000 employees from all business units worldwide could register as investors in a modified first come, first serve mode that ensured representative distribution of participants. All accepted investors were endowed with 2000 USD. An even larger run was conducted in 2016, the IBM Cognitive Build. It centered around ideas for solutions related to cognitive computing that could be offered to IBM customers. However, setup and policies of this run differed from the outlined process, as the aim was to involve as many employees as possible but still provide a meaningful budget to everybody. As the resulting overall budget would easily become unreasonable for such a contest, it was decided to rather use the endowed money as a mere voting mechanism. Thus, in Cognitive Build, ECF and a more traditional idea contest including crowd voting as mentioned in Sect. 12.3.1 were integrated. Moreover, Cognitive Build was carried out in rounds, including decisions of a decision-making panel. Hence, Cognitive Build was a hybrid mechanism.

As a summary, we categorize ECF in its original form according to the CI genome (Malone et al. 2010) as follows:

**What:**

1. **Create.** From the perspective of the proposer, the main task is to create compelling ideas and propose them on the ECF site. Nevertheless, compared to decision-making, the create aspect has less emphasis.

2. **Decide.** The predominant task for backers in ECF is to decide by using their wallet. As the name crowdfunding suggests, the decision is made through funding actions. Moreover, other than in all previously introduced mechanisms crowd decisions in ECF are final, i.e. there is no subsequent management decision.

**How:**

1. **Independent.** When creating the proposal for ECF, proposers start by writing up a proposal independently. They are likely to benefit from the questions and comments received from other participants during the funding phase. Nevertheless, every proposer decides individually what to include in the proposal. The general character of the creation function in ECF is to collect proposals. Malone et al. (2010) characterize collection as an independent act.
2. **Dependent.** Decision-making is carried out collaboratively in ECF. Backers conduct their decisions collaboratively, but not necessarily consensus-oriented. While backers decide independently what proposals to support, they are bound to the collective decision at the end, as they are normally not able to fully fund a proposal themselves. Moreover, they can see others' funding actions, and interact with proposers and other backers through comments. Hence, the degree of collaboration is much higher than in the case of idea markets, where coordination between participants takes place over stock prices of ideas.

**Who: Crowd**. ECF is clearly designed for crowds. This applies to the creation of proposals that are submitted to ECF as well as to the decision about them. Both tasks are divided and assigned to a wide audience. Organizational boundaries only play a role with regard to which business unit conducts the run, i.e. it is at the discretion of the unit which employees to involve.

**Why: Glory & Love.** There is always a certain level of motivation through money present, as successful projects benefit the company directly and, thus, each employee indirectly. Nevertheless, participants of ECF are more motivated to participate for reasons of love and glory. Love, in particular, applies to the backers, as they neither receive a direct payoff nor particular visibility or recognition from others besides the proposers. For proposers, glory plays a potentially important role, as their names are visible on the description page of their respective proposal, hence, can be easily associated with the proposals.

### *12.3.5 Instrument Comparison*

We close this section by comparing the introduced CI mechanisms for involving employees in service innovation processes. The objective of this comparison is twofold. Firstly, it should help to clarify how different the mechanisms are from each other. This applies in particular to differentiate the latest mechanism, namely ECF, from the other more established ones. Secondly, the comparison should reflect

**Table 12.1** Collective Intelligence Approaches for Service Innovation

| | | | Innovation Communities | | Idea Markets | | Participatory Budgeting | | Enterprise Crowdfunding | |
|---|---|---|---|---|---|---|---|---|---|---|
| Collective Intelligence Genome (Malone et al., 2010) | What | | Create | Decide | Create | Decide | Create | Decide | Create | Decide |
| | How | Dependent | • | • | | • | • | • | ° | • |
| | | Independent | | | • | | | | • | |
| | Who | Crowd | • | • | ° | • | ° | ° | • | • |
| | | Hierarchy | | •[a] | •[b] | •[a] | •[b] | •[a] | | |
| | Why | Money | | | | • | ° | ° | | |
| | | Love | • | • | ° | ° | • | • | ° | • |
| | | Glory | | | • | | | | • | |
| Detailed Differentiation from the Crowd Perspective | Conceptual | Threshold | | | | | | • | | • |
| | | Ranking | | • | | • | | | | |
| | Structural | Vehicle: Money | | | | • | | • | | • |
| | | Vehicle: Votes | | • | | | | | | |
| | | Inf. Aggregation | | • | | • | | • | | |
| | | Final Decision | | | | | | | | • |
| | Perceived | Trustee | | | | | | | | • |
| | | Inf. Source | | • | | • | | • | | |
| SI Recom-mendations[c] | Cross-Unit Collaboration | | • | ° | ° | | | | • | ° |
| | Individual Incentive | | | | ° | | | | • | ° |
| | Community Work | | ° | | | | ° | ° | ° | ° |
| | Customer-Employee Mix | | opt. | opt. | opt. | opt. | (opt.) | (opt.) | opt. | opt. |

Notes.

[a]The final decision is taken by an official body or by decision-makers in the organization
[b]Often suggestions are provided by an official body or by decision-makers.
[c]Service innovation specific recommendations, see Sect. 12.2.4
Gray/light gray/white fields indicate the functions with primary/medium/low emphasis
• = fully applies; ° = partially applies

on the mechanisms fit with the recommendations derived from service science literature in Sect. 12.2.4. All results of the comparison are summarized in Table 12.1.

In terms of the first objective, it seems natural to leverage the mechanisms previously discussed categorization according to the CI genome by Malone et al. (2010) to contrast them. Unfortunately, as a look at Table 12.1 reveals, this leaves a somewhat blurry picture. This may have two reasons. Either the mechanisms are very similar, or the dimensions provided by the genome are too superficial to clearly

outline their differentiating characteristics. In response, we reflect on the mechanisms' descriptions to see whether we are able to identify meaningful differentiating criteria that go beyond the "what, how, who, why" categorization of the CI genome. For this, we take the perspective of the latest mechanism ECF and compare it against the others. While the CI genome is an established framework, the reflection is rather an act of contemplation. By doing so, we are able to identify differences on three levels:

(1) On a **conceptual** level, ECF is a funding mechanism. Hence, its basic idea differs from ranking mechanisms as often realized in innovation communities or innovation contests through votes or scores, or through trading as seen in idea markets. This has implications on the proposals that are selected through the mechanism. Voting, scoring, and trading help to identify those proposals, that the crowd as a whole considers to be the best. In participatory budgeting and ECF, proposals need to accumulate just enough funding to reach their threshold. In PB this is achieved through mutual deliberation. ECF however, is a crowd approach but the decisions are made by a collection of backers (potentially sharing common interests) funding proposals.

(2) **Structurally**, the endowment of money to individuals as their decision-making vehicle instead of votes or scores distinguishes ECF from the typical realizations of innovation communities and contests. However, the provision of money also applies to idea markets and participatory budgeting. Nevertheless, idea markets are mechanisms for information aggregation, the actual decisions are drawn by decision makers observing the idea market. Likewise, in participatory budgeting, the decision of the participants has to be approved by an official body. Thus, the absence of a concluding management decision or veto in ECF constitutes the difference between information aggregation for decision-making and de facto decisions.

(3) As a consequence, ECF also differs from the other approaches on a **perceptional** level. Endowing money to individuals instead of asking them to vote is arguably a strong signal for the importance of their contribution. Humans (at least in the western world) have a clear concept of the value of money they can spend at their own discretion compared to a rather abstract understanding of votes or scores. The absence of a management veto amplifies this perception even further. In ECF, employees become trustees and real decision makers for their employer rather than an information source.

In terms of the second objective, we investigate whether the outlined mechanisms adhere to the design recommendations that we derived from service science literature in Sect. 12.2.4. In this regard, we also find interesting differences between the mechanisms:

Recommendation 1 calls for supporting cross-unit collaboration. This aspect is supported by innovation communities like the innovation jam as well as ECF. Both mechanisms facilitate cross-unit collaboration through their conceptual goal to involve a large and diverse audience as well as through features for mutual exchange of thoughts such as comments, updates, sharing, and the like. This particularly applies to the create facet of the CI genome mechanisms. For decision-making,

cross-unit collaboration plays a less prominent role. Idea markets also aim for involving a diverse audience. However, they rely on coordination of participants by market mechanisms in the context of decision-making only. For creative tasks, collaboration is not provided in the core mechanism, but collaborative creation of ideas can be supplemented. Hence, collaboration is very limited, a more intensive, verbal exchange of thoughts is not facilitated by default. Participatory Budgeting (PB) in contrast strongly encourages verbal exchange of thoughts. However, its original notion is to involve members of an existing community, rather than facilitate cross-community interaction. In a company setting however, one could decide to involve an audience from various units to one PB implementation. In this case, the line between PB and ECF becomes blurry.

Recommendation 2 suggests facilitating employees' participation in an innovation mechanism through possibilities for strengthening their personal status. Conceptually, this recommendation correlates with the glory gene in the why dimension of the CI genome dimension. In innovation communities, all participants contribute to joint results. Gaining glory is difficult in this setting, given the abundance of contributions from various sides. In innovation contests however, there is an opportunity for proposers to improve their status in case they are successful. Improving one's own status by participating in idea markets and trading idea shares is also limited. Idea generation plays a subordinate role in idea markets. However, depending on how the portfolio in question is built up, i.e. who contributes the ideas, there might be opportunities for being personally associated with a proposed idea. PB as a form of democratic decision-making is, by definition, not designed for making individuals stick out. Compared to idea markets, idea generation plays a more prominent role in ECF. Proposing ideas personally or in small teams is a dedicated part of the mechanism. Getting funded by the crowd is a form of personal recognition. Also, the decision-making side of the mechanism provides at least some opportunities for glory, as it typically shows the names of all backers. Moreover, backers can receive rewards from proposers for supporting their endeavor (e.g. being mentioned on a project website). Hence, some recognition for supporting proposals is possible.

Recommendation 3 addresses the notion of building up and working in communities around shared interests. As this requires mutual exchange of thoughts as well as addressability of other participants, mechanisms providing strong collaboration and social software-like features are at an advantage in this regard. Innovation communities, PB, and ECF fall into this category. Nevertheless, while these three mechanisms support the forming of such communities, they do not facilitate team work in the sense of, for instance, jointly working on documents. By design, idea markets are not geared towards forming and working in communities.

Recommendation 4 suggests involving customers and employees at the same time into the generation and evaluation of ideas. By definition, none of the introduced mechanisms is limited for use with employees only. Thus, potentially all of them allow to follow this suggestion. However, inviting a mixed audience would not follow the original PB notion of involving members of a community such as a

district, a town, etc. in decisions they are affected by. Nevertheless, PB mechanisms used by companies are far blurrier in this regard (e.g. Hohmann 2016).

In summary, based on the instrument comparison the latest approach ECF seems to be particularly interesting to employ in service innovation scenarios. However, while the approach has its strength in involving employees in idea evaluation, i.e. decision-making, it also has limitations in terms of developing new ideas for services. Thus, for service organizations making use of the introduced approaches, it is rather a question of orchestration than pure choice. In particular, the aspect of community work, meaning the active facilitation of co-development or co-design of services is only weakly covered so far. Hence, if we want to leverage a large number of participants for first idea development, conceptualization of the ideas to selecting and realizing them, an integration of approaches that are strong in the area of creativity, such as innovation communities, with more decision-making oriented mechanisms, such as ECF, may be a good starting point.

## 12.4 Conclusion

In this chapter, we have reflected on the potential of and instruments for involving employees in service innovation processes. Based on a discussion of value co-creation scenarios in the context of service innovation, we have conjectured that frontline employees of service providers may be particularly valuable participants as they can be proxies for their customers and, thus, can represent a customer perspective in service innovation processes. The quality of these proxies may increase with the depth of insights frontline employees can gain of their customers. Moreover, according to literature, these employees can also ensure the strategic and cultural fit of service innovations to their organizations, to avoid a reported drawback of directly involving customers into the service innovation process. Hence, we have suggested to leverage the potential of large amounts of these employees through recent collective intelligence instruments designed for organization-internal use. This is particularly fitting for service firms where humans are directly involved in providing services to the organization's customers, as it is the case with for instance professional service firms. In these cases, frontline employees account for a large share of the organization's employees. Thus, inviting all employees of the firm to participate in service innovation endeavors by means of collective intelligence mechanisms is likely to result in a strong representation of the customer perspective. For effectively leveraging the knowledge of frontline employees, we have derived recommendations regarding the nature of such collective intelligence mechanisms. Moreover, we have introduced and compared collective intelligence instruments used in the recent past in the context of involving employees in innovation endeavors and have matched them with the recommendations mentioned above. We have especially emphasized enterprise crowdfunding (ECF), the latest among these internal collective intelligence instruments, which seems to match our recommendations quite well.

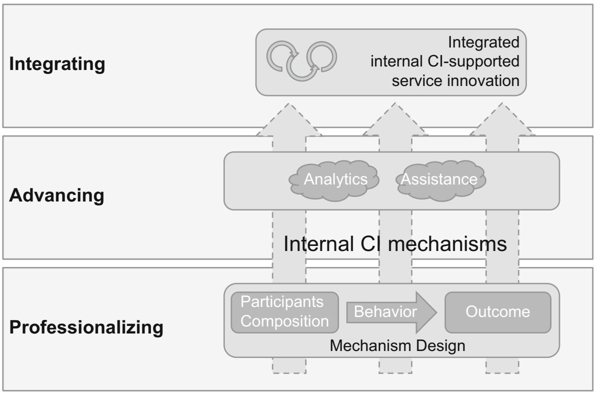



**Fig. 12.3** Future research on internal CI for service innovation

So far, we have provided theoretical considerations and a status quo in terms of CI mechanisms. However, the definitions of these mechanisms leave room for interpretation and, thus, modification and extension. In fact, the importance of a more sophisticated design of these approaches to leverage their full potential has been emphasized (Cooper and Edgett 2008). Moreover, finding new forms of integrating customer perspectives into the service innovation process has been suggested recently (Patricio et al. 2018). Correspondingly, this chapter may be considered as a starting point for further related research. For this we propose three avenues (Fig. 12.3):

**(1) Professionalizing internal CI mechanisms for supporting the service innovation process.** Empirical research concerning internal collective intelligence approaches is limited (Bayus 2013; Zuchowski et al. 2016). Moreover, it may be difficult to conduct enough empirical research that is unbiased by environmental circumstances to allow for targeted professionalization of the mechanisms design. Hence, we suggest considering more experimental research to disentangle the interplay between the composition of participants to involve in CI mechanisms, the design of the mechanism itself, the behavior participants exhibit, and the outcome resulting from it.

In terms of the types of participants to involve, we have so far focused on leveraging a customer perspective for the service innovation process. However, team composition for successful innovation is a multifaceted endeavor. In recommendation 4 we have suggested to combine customer and provider employees. Trischler et al. (2018) support this view but point out that intra-team factors may have moderating effects on such team's outcome. This connects to a broad field of research on diversity, culture and outcome of teams involved in innovation processes (Hirst et al. 2009; Hoever et al. 2012; Pieterse et al. 2013). We can raise the question whether findings that apply to teams also apply to crowds and, relatedly, what an ideal crowd for supporting service innovation endeavors looks like.

Regarding the design of the CI mechanisms themselves, research should identify options for improving the mechanisms' contributions to service innovation endeavors. Identifying features for supporting our recommendations 1 to 3 falls

into this category. Concerning cross-unit collaboration (recommendation 1), the question may be whether it is enough to provide an opportunity for collaboration and remove known obstacles, e.g. competition for budgets, or active facilitation of collaboration is advisable. Concerning recommendation 2 it is important to find ways to make employees contribute their valuable knowledge to the innovation process in return for support of their personal agenda of maintaining their expert status (Valtakoski and Järvi 2016). In CI mechanisms, often communities of individuals with common interests emerge. Concerning team work (recommendation 3), we may question if the effectiveness of these communities can be furthered by incorporating complementary tools and methods, for instance from the service design field (Patricio et al. 2018).

Influenced by the design of the CI mechanism the participants will exhibit a certain behavior that eventually contributes to the outcome of the mechanism (Smith 1982). Understanding the behavior of participants and the types and qualities of outcome may help to specify the role internal CI mechanisms should resume in service innovation endeavors. This includes, in case of frontline employees, if they play the role of proxies for their customers automatically or if this needs to be encouraged by a feature of the respective CI mechanism.

**(2)** Secondly, we suggest to **advance internal CI mechanisms through cognitive assistance**. Analytical possibilities have been improved in the recent past and topics such as cognitive assistance are discussed (Demirkan et al. 2015). Correspondingly, we suggest investigating whether cognitive assistance can catalyze employee collective intelligence in service innovation endeavors. For instance, the creativity or decision quality of CI mechanisms may reach a new level by introducing artificial intelligence assistants to the group of human participants in CI mechanisms. Such assistants may support human participants in applying different perspectives or a broader information base to the creative or decision-making task they are asked to solve. Hence, the human abilities in terms of creativity and developing a perception of an idea for innovation beyond pure facts can be complemented with the strength of an agent to quickly learn based on extensive and diverse data sets.

**(3)** As a third avenue for future research we suggest studying the **integration of internal CI mechanisms** instead of looking at each of them individually. The aim is to allow for a more holistic and seamless way to leverage (frontline) employees' collective intelligence throughout the entire service innovation process instead of isolated activities only, a reported shortcoming (Bonabeau 2009; West and Bogers 2014).

With the discussions of this chapter we hope to contribute to advancing service innovation by leveraging the knowledge and engagement of the workforce: As (frontline) employees are reasonable proxies for customers, they may offer easy "open" innovation opportunities. Employee collective intelligence approaches need to adhere to four elementary recommendations. The exemplary instruments shown and their comparison should provide valuable orientation for innovation managers to unleash the contribution of their employees. Our research agenda should pave the way to improve existing and develop new employee collective intelligence instruments.

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# Chapter 13
# A Multilayer Framework for Service System Analysis

**Robert Blair Frost, Michael Cheng, and Kelly Lyons**

**Abstract** As service science evolves as a discipline, an important ongoing focus for research has been modeling and representing entities as service systems in order to understand, represent, and innovate within service systems. Recently, there has been interest in exploring how data and data analytics are enabling service innovations within more traditional organizations. In this chapter, we present and evaluate a multilayer framework and analysis technique that can be used to describe an organization as a service system. The framework characterizes service systems within institutional arrangements, identifies key service system components, and describes the service ecosystem, internal relationships, and value-cocreating interactions. To test and validate the framework, we present the results of using the framework to analyze a mining company as a service system and identify ways in which data-intensive technologies can be used to integrate service innovations within it.

**Keywords** Service systems · Analysis · Frameworks · Data-intensive systems

## 13.1 Introduction

An important and consistent goal of service science is to improve understanding of and innovation in service systems though the application of management, scientific, and engineering techniques (Spohrer and Maglio 2008; Maglio et al. 2009). Being able to represent organizations as service systems is an important step in understanding service systems and is necessary for improving and innovating within them. There have been several frameworks proposed for representing entities as service systems (see, for example, Katzan 2009; Spohrer et al. 2012; Lyons and Tracy 2013; Glushko 2013).

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_13

In their review of the literature published up to 2011 on service systems and service system elements, Lyons and Tracy (2013) synthesized several existing definitions and ontologies of service system elements together into a single framework (hereafter referred to as the Service System Framework). Since that time, there have been considerable advances in service science research and organizations such as manufacturing and commodity based entities are increasingly using data-intensive techniques (artificial intelligence (AI), internet of things (IoT), bots, augmented reality, etc.) to transform to service businesses. There has also been growing research interest in how advancements in data analytics and data-intensive techniques are impacting service systems (Breidbach and Maglio 2013; Herterich et al. 2016; Borangiu and Polese 2017; Lim et al. 2018a; b). These changes and advances necessitate an update to the Service System Framework.

We started with the service system components in the Service System Framework and mapped the results from a recent systematic literature review (Frost and Lyons 2017) onto the concept matrix template of Webster and Watson (2002). The conceptual foci of the articles reviewed on the subject of service system elements were then analyzed and recorded in the concept matrix. From this conceptual analysis, we developed a Multilayer Service System Framework (MLSSF) that is an evolution of the 2013 Service System Framework. In this chapter, we present the Multilayer Service System Framework and show how it can be used to analyze a mining company that is innovating through data-intensive clean technology.

## 13.2 Multilayer Service System Framework (MLSSF)

The MLSSF, depicted in Fig. 13.1, is arranged in five layers: ecosystem, system, architecture, component, and typology. Each is described below.

### *13.2.1 Ecosystem and System Layers*

The MLSSF explicitly recognizes the distinction between service ecosystems and service systems, positioning the ecosystem on a layer of abstraction above its constituent systems. The system layer decomposes into every element in the framework other than the service ecosystem, and although the only elements present on the system layer are service systems, the system layer must contain multiple service systems in order to analyze the service ecosystem.

#### 13.2.1.1 Service Ecosystem

The service system and service ecosystem concepts are often scoped and defined with extreme similarity or perceived interchangeably (see Barrett et al. 2015;

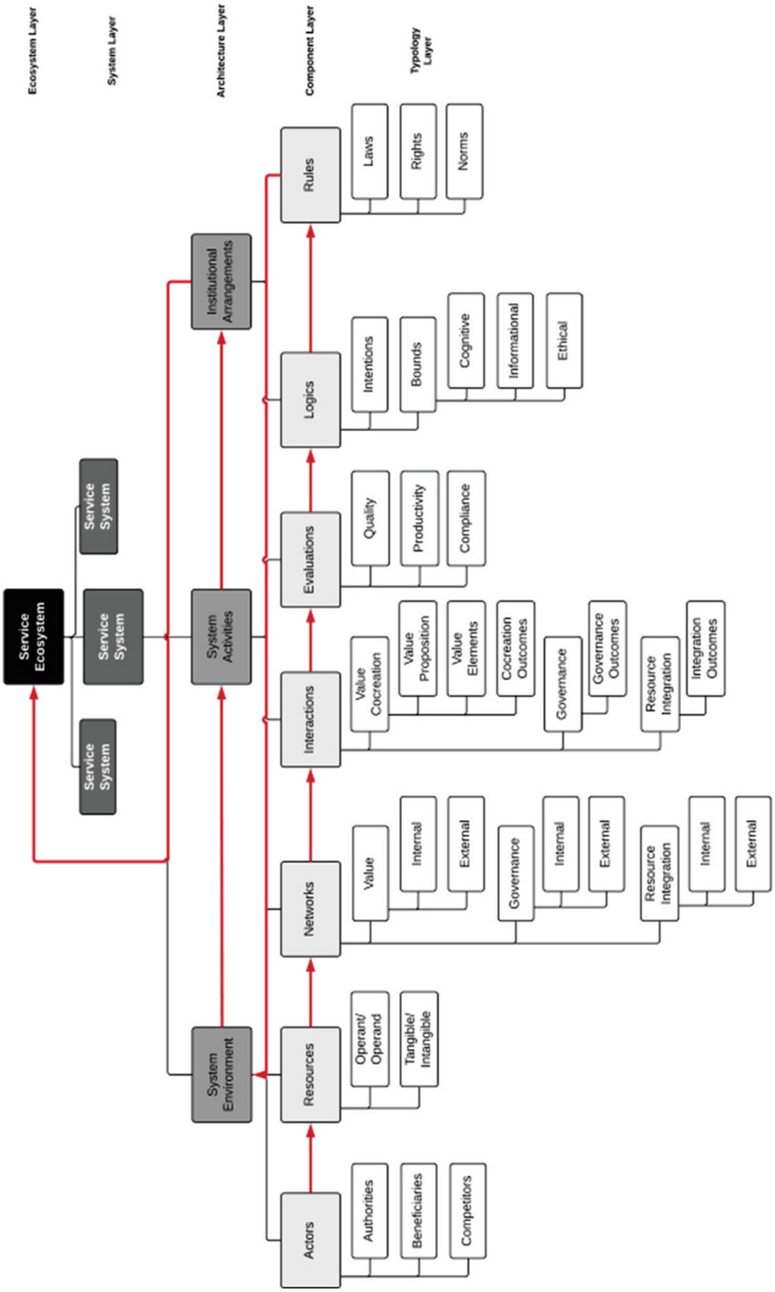


**Fig. 13.1** The multilayer service system framework

Kutsikos et al. 2014; Mele et al. 2014; Wan and Zhang 2013), prompting a suggestion that future studies should more firmly demarcate the boundary between service systems and service ecosystems. The MLSSF demarcates such a boundary, observing Frow et al.'s interpretation of the service ecosystem as a "higher level system [relative to a service system]" (2014, p. 332) and Akaka and Vargo's claim that the service ecosystem enables "interaction within and among service systems" (2014, p. 371). Therefore, a service ecosystem necessarily contains more than one service system and could theoretically contain a large number of service systems. In fact, within a service ecosystem, we see the evolution of new types of service system entities and the growth of new types of entities each with its own architecture (Spohrer et al. 2012). This is especially relevant as artificial intelligence (AI), internet of things (IoT), bots, augmented reality, etc. transform the service landscape.

#### 13.2.1.2 Service System

The definition of a service system posed by Maglio et al. is suitable for further clarifying the boundary between the ecosystem and system layers: a service system is thus observed as "an open system (1) capable of improving the state of another system through sharing or applying its resources . . . and (2) capable of improving its own state by acquiring external resources" (2009, p. 403).

### *13.2.2 Architecture Layer*

The architecture layer and the concept of a service system architecture is not to be confused with notions of service-oriented architectures or business architectures for services—those concepts are rooted in bodies of literature which intersect with the service science literature, but are not endemic to the service system abstraction. In this context, a service system architecture is understood as a structured assemblage of interdependent components which perform a distinct, synergistic function when conjoined.

Three service system architectures reside in the architecture layer: the system environment, the system activities, and the institutional arrangements. Each of these architectures join together an assemblage of components to fulfill a function beyond the power of any one component. It is through the interdependencies and interactions that exist among the architectures that the service system as a whole attains the structure required for the system's components to operate. The three interacting architectures describe: (1) the *system environment* or "stuff" that give it the ability to be or act as a service system; (2) the *system activities* that get carried out in its role as a service system; and, (3) the *institutional arrangements* that define the ways in which it conducts itself as a service system.

#### 13.2.2.1 System Environment

The system environment is a structured collection of static elements (resources, actors, and networks) which provide the preconditions and venue required for interaction and evaluation. The elements in the system environment (for example, the identities of actors or the reach of networks) are only "static" in a snapshot of the service system; the environment gradually evolves through iterative interaction and evaluation, but its growth moves more slowly than the rapid and frequent movements found in the system activities architectural component.

The concept of the system environment is essentially an adaptation of Lusch and Nambisan's (2015) conception of a service platform. Lusch and Nambisan define the service platform as "a modular structure that comprises tangible and intangible components (resources) and facilitates the interaction of actors and resources (or resource bundles)" (2015, p. 166). The system environment possesses all of those qualities: it is modular, containing resources as one of its classes of components; it is a structured assemblage; its component networks not only facilitate interaction, but provide the venue in which actor-resource interactions occur. However, the service platform is conceived of as a limited stage for service innovation rather than service provision and it does not afford any interaction types other than resource integration interactions. It functions as an expanded version of the service platform, providing the structure and functionality needed to support resource integration, value cocreation, and governance interactions, as well as evaluations. Additionally, a system environment is a more appropriate analogy for the concept than platform, conjuring a vision of the setting in which activities and relationships are embedded.

#### 13.2.2.2 System Activities

The system activities is the full universe of relationships which exist among actors, resources, and networks within a given service system whereas a service ecosystem is a collection of service systems with its own higher-level activities architecture which includes the lower-level service activities of its constituent systems. The system activities architecture should not be confused with networks, which are components of the system environment architecture. Networks are bridges between actors or between actors and resources, whereas the function of the system activities is to enact the actual interactions and evaluations which cross those bridges.

#### 13.2.2.3 Institutional Arrangements

The institutional arrangements architecture and its components are defined as a set of institutions "nested in multiple levels of social systems" (Vargo et al. 2015, p. 67). In turn, an institution is a set of "humanly devised rules, norms, and meanings that

enable and constrain human action" (p. 64). Each actor in a service system brings their own institutions to the system, collectively assembling institutional arrangements. Examples actor types (each with their own institutions) include authorities, beneficiaries, and competitors. Important types of authority actors are federal or national governments which have powers of coercion associated with their institutions.

Institutional and sociological perspectives are becoming more prominent in the service science literature (Frost and Lyons 2017). Vargo and Lusch (2016) consider institutions to be the coordinating mechanisms of value cocreation. The function the service system's institutional arrangements is twofold: the arrangements infuse actors with bounded rationality and intentionality through institutional logics, and the arrangements set rules which impose social boundaries on actor behavior. Applying institutional logics and rules to actors has a cascading effect throughout the system environment and system activities, causing every resource, network, interaction, and evaluation to be shaped by the motivations and limitations infused into actors by the institutional arrangements. Through their gradual co-evolution, the system environment and activities can together reciprocate that change, re-shaping the institutional arrangements as new logics and rules are formed over the course of many interactions and evaluations.

### *13.2.3 Component and Typology Layers*

The component layer sits underneath the architecture layer and identifies key components within each architecture (for example, actors, resources, and networks are components of the system environment architecture). Components within the MLSSF are granular, interactive constructs serving a specific purpose in performing the service system's operations. The typology layer resides below the component layer—at the very bottom of the taxonomy—and defines the typology of component types, which are the differentiating characteristics possessed by different components, and sub-types, which differentiate types. For example, resources are a key component of service systems and, in the MLSSF, sit under the system environment architecture. Resources have different types (in the typology layer of the MLSSF): operant or operand and tangible or intangible.

Together, assemblages of particular components form architectures, which reside in the architecture layer above the component layer. It should be noted that while component types are used to separate components into different conceptual categories, the relationship between architectures and components is not the same: components are integral parts of architectures which must all be present for the service system to operate, whereas types add context and features to components. Components and component types receive discussion in nearly all of the recent service science literature (Frost and Lyons 2017), and in the MLSSF, they remain as important to the service system as ever.

In total, the MLSSF identifies seven components and 34 component types/sub-types (see Fig. 13.1). The system environment architecture is composed of the actors, resources, and networks components. The system activities architecture is composed of the interactions and evaluations components. The institutional arrangements architecture is composed of the logics and rules components. In the remainder of this section we describe each component, each component type/sub-type, and how the definitions were influenced by the literature.

#### 13.2.3.1 Actors

In the Service System Framework (Lyons and Tracy 2013), entities were defined "resource integrators that enable exchange for the purpose of value cocreation within or between service systems" (p. 21), and stakeholders were observed as "a perspective rather than an entity such that a service system entity can maintain multiple stakeholder perspectives" (p. 22). The MLSSF synthesizes the ontological features of entities and stakeholders, observing actors as intentional agents with (1) resource-processing, value-processing, governance, evaluation, and communication capabilities, and (2) distinct stakeholder perspectives. In this context, the concept of an intentional agent is derived from Lessard and Yu's re-conceptualization of service system entities as intentional agents, defined as "social entities that depend on one another to reach their goals; they thus intentionally enter in relationships with one another to improve their well-being" (2013, p. 69).

The entity and stakeholder components were sometimes regarded as ambiguous in the literature, with the components and their features treated interchangeably (see Maglio and Spohrer's (2013, p. 667) use of the term "stakeholder entities" as well as Mele et al. (2014) and Golnam et al. 2012). Furthermore, discussions of actor-network theory have been observed in service science literature (Frost and Lyons 2017), and in one article, different entity types were described before abandoning the concept altogether and adopting the language of actors and actor-networks instead (Frow et al. 2015, p. 464).

It is important to note that terminology is discipline dependent. The choice of the term "entities" derives from its preferential use in law. The term "actors" is more prominent in social sciences such as economics and behavioral sciences. In computer science, the term, "actor" refers to human and non-human actors. The use of the term entity signals that legal aspects of service systems are important; after all, the main characteristic of a person (a key resource in every service system) is rights and responsibilities and every service system has a focal resource, a person, who takes responsibility. Taking a more general perspective, we consider Vargo and Lusch's (2016) claim that institutions and institutional arrangements are "actor-generated" (p. 8) as signalling the need to develop a unified intentional agent construct in order to make the service system abstraction more compatible with institutional and sociological perspectives. The actor is such a construct, possessing intentionality as well as the resource-processing, governance, and communication capabilities.

The MLSSF includes three types of actors: authorities, beneficiaries, and competitors. Authorities regulate and control the operations of the service system, evaluating compliance, participating in governance interactions, and modifying institutional rules through governance networks. Government entities and regulatory agencies are examples of authority actors. Beneficiaries are actors which use resource integration networks and value networks to integrate resources with the assumption that doing so will ultimately result in successful value cocreation and mutual benefit. Beneficiaries can be socially contextualized as individuals, groups, organizations, communities, nations, or any other group of individuals. Previously, beneficiaries were divided between the customer and provider stakeholder types, as well as the customer, provider, and producer entity types (Lyons and Tracy 2013). However, upon closer analysis, the division between customers and providers appears to be a vestige of goods-dominant logic: in a mutual cocreation of value, both beneficiaries come to the table with a value proposition and act as customers and providers simultaneously (Vargo and Lusch 2016). When analyzing stakeholder perspectives, especially in legal or liability contexts, it is important to describe and clarify roles within the beneficiary category (that is, provider or customer).

In opposition to beneficiaries, competitors are the actors who are disadvantaged by a given value cocreation interaction, though they are not directly involved in the interaction themselves. Competitors do not necessarily have to be businesses that are financially disadvantaged by one another's value cocreation interactions—social enterprises, governments, or communities can be disadvantaged by one another's success in the sense that improved performance in one actor or group of actors compels competitor actors to improve their performance if they wish to preserve their public image. In some cases, a social enterprise, government, or community may not have the resources to keep pace with the improvements of its competitors, putting it at a disadvantage which jeopardizes its image.

#### 13.2.3.2 Resources

The conceptualization of the resources component in the MLSSF remains the same as in the Service System Framework, "the things that are exchanged for the purpose of creating value" (Lyons and Tracy 2013 p. 20); however, the number of resource types has been significantly reduced in order to improve the usability and versatility of the framework. Access rights determine how resources can be used in the exchange. The fundamental distinction between operand and operant resources remains, and another fundamental distinction between tangible and intangible resources has been added. However, the physical/conceptual distinction from the previous framework was not included in the MLSSF due to its being difficult to interpret in many use cases. For example, information can simultaneously have both a physical and conceptual instantiation; a computer program can be interpreted as a physical object that appears on a screen after being processed as electrical signals, but it can also be interpreted as conceptual, algorithmic structure. To simplify the framework, sub-types such as people, organizations, shared information, and

technology were removed. Those sub-types are examples of instances within categories and it can be difficult to produce an exhaustive list of resource instances so we do not include an instance list in the MLSSF. Using two dichotomies of operand/operant and tangible/intangible offers the framework's users more simplicity and flexibility in analysis. This does not mean that sub-types such as physical/non-physical and rights/no rights should not be considered in analyses.

#### 13.2.3.3 Networks

Defining networks as structural clusters of pathways between actors, resources, and institutions through which interaction and evaluation occur affirms the component's role as the bridge between the system environment, system activities, and institutional arrangements architectures.

The networks component has three types: value networks, governance networks, and resource integration networks. Value networks are interpreted as the set of pathways through which value cocreation interactions can occur. Governance networks are interpreted as the set of pathways through which governance interactions and evaluations can occur between actors, resources, and institutions. Resource integration networks are interpreted as the set of pathways through which resource integration interactions can occur between actors and resources.

Each of the network types has an internal and external qualifier as its two sub-types. Internal networks can be thought of as the structures which bridge the system environment, system activities, and institutional arrangements architectures. External networks can be thought of as the structures which bridge a given service system with the system environment, system activities, and/or institutional arrangements of an external service system. In this way, external networks are the key to connecting and interfacing service systems under the umbrella of a single service ecosystem.

#### 13.2.3.4 Interactions

Interactions are the processes through which actors exercise their capabilities to cocreate value, integrate resources, and govern. The importance of resource integration was asserted throughout the reviewed literature (e.g. in Vargo and Lusch 2016; Edvardsson et al. 2015; Laud et al. 2015; Lusch and Nambisan 2015; Siltaloppi and Vargo 2014), with Siltaloppi and Vargo defining resource integration as a process which "... captures the broad range of interactive [emphasis added] behaviors in which an actor or a service system applies knowledge and skills, in conjunction with other available operant and operand resources, to improve the state of others, and reciprocally, the state of oneself" (2014, p. 1279). The evolutionary motivation for performing high-productivity resource integration will be discussed in greater detail in outlining the evaluations component. It is clear that resource integration represents

a distinct type of actor-to-resource interaction which supports value cocreation, whereas value cocreation represents an actor-to-actor interaction.

Outcomes are a feature of value cocreation interactions, not a component distinct from interactions, as the word "outcome" implies that some process (in this case, an interaction) must have preceded it. Although it is not visualized in Fig. 13.1, the breakdown of potential outcome results derived from Maglio et al.'s (2009) ISPAR model shapes the range of potential value cocreation outcomes in the MLSSF. The MLSSF divides the concept of outcomes into value cocreation outcomes, governance outcomes, and resource integration outcomes. At this time, the potential range of governance outcomes and resource integration outcomes remains unexplored, presenting an interesting direction for future research.

#### 13.2.3.5 Evaluations

Evaluations are the processes through which actors exercise their capabilities to evaluate performance measures in order to evolve the service system in future interactions. The evaluations component is positioned within the system activities architecture because an evaluation is a dynamic relationship between an actor and another actor, a resource, or an institution; an evaluation is not a static element. It is separated from the interactions component because an evaluation can potentially be a one-way assessment or unreturned observation, in which case it is not interactive. The evaluations component has an important purpose which was not acknowledged in the service system framework of Lyons and Tracy (2013): evaluation serves as the evolutionary mechanism of the service system. Understanding how evaluation leads to evolution in service systems is an opportunity for future research.

Evaluations of quality and productivity can be conducted by any actor type, but are usually conducted by either beneficiaries or competitors. Quality evaluations typically measure the performance of beneficiaries and competitors in operating value networks and enacting value cocreation; productivity evaluations typically measure the performance of beneficiaries and competitors in operating resource integration networks and enacting resource integration. Evaluations of compliance can be conducted by any actor type, but are usually conducted by authorities. Evaluations of compliance typically measure the performance of beneficiaries, governance networks, governance interactions, and rules.

Innovation is a consequence of repeated evaluation and repeated adaptation of the service system in response to evaluation. By iteratively evaluating the system's performance and adjusting intentions after the evaluation process, actors naturally evolve themselves along with the rest of the system environment, the system activities, and the institutional arrangements. Furthermore, measures that are used to evaluate service systems are an example of kind of resource within the system environment of the service system.

#### 13.2.3.6 Logics

In the context of a service system, logics consist of the intentions of the actors participating in the system and the epistemological boundaries that constrain their reasoning. Commonsense reasoning varies with cultures, including conceptions of time. Understanding the ways in which different reasoning affects logics and intentions in service systems is an interesting area of future research. As Lessard and Yu note of the prevailing conceptualizations of a service system, "a key aspect that has not been addressed is the strategic, intentional motivations that drive service system interactions" (2013, p. 69). The logics component—and more broadly, the institutional arrangements architecture—fills that gap in the literature, granting actors with goal-oriented intentionality, rational judgment, and bounds on that rationality. More work is needed that looks into institutional perspectives in service systems such that the relationship between logics and other components can be explored in more detail, and different typological features of intentions can be specified. Lessard and Yu hint at some of those potential features in stating that the intentionality within a service system can be broken down into high-level interests, expected benefits, value propositions, and perceived value. However, for the time being, the interpretation of intentions is largely being left open to framework users, allowing for new developments in the literature to be applied to the intentions element on an as-needed basis.

Three types of bounds are identified: cognitive, informational, and ethical. These bounds on logics are borrowed from Simon's (1976) work on bounded rationality, in which the decision-making of rational actors is limited by the cognitive abilities, the information available to them, and their ethics (conceived of by Simon as the "values" actors associate with potential behaviors, though this sense of the word would be confused with service science's concept of values if it were imported into the MLSSF). As a result, the performance of actors in the service system is limited by their ability to process information resources (and other resources), the amount of resources available to them (especially information resources), and their ethical values which prohibit them from enacting what they would consider to be unethical or non-valuable interactions.

#### 13.2.3.7 Rules

Rules are the social boundaries that constrain the behavior of the actors participating in the service system. They are separate from bounds on logics in that logical bounds are epistemological constraints, whereas rules are social constraints which limit the range of acceptable social behaviors. The MLSSF specifies three types of rules: laws, rights, and norms. Laws can refer to the boundaries on social behavior imposed on the public by governments, but they can also be understood more broadly as rules which "ensure compliance to regulations or policy" (Lyons and Tracy 2013, p. 21) in the context of an organization's internal regulations and policies. Rights can be

thought of as the permissions afforded to actors by authorities to access and use resources and networks. Norms are a type of rule which are not formally decreed by an authority—rather, they are culturally embedded, tacit expectations of social behavior. Including norms in the MLSSF allows for a consideration of how culture impacts the service system's interactions. It also makes the framework more closely aligned with Laud et al.'s (2015) assertion that the structural, relational, and cultural embeddedness of service system actors must be considered in order to fully understand the system activities.

### 13.2.4 Analysis Sequence

Descriptive analysis approaches can be strengthened with the addition of prescriptive methods, as the former describes the nature of a target of analysis and the latter specifies an ideal methodological process for analyzing it (Frost and Lyons 2017). Before beginning any service system analysis, it is important to determine the goal of analysis, scope the operational boundaries of the service system, and adjust the approach to analysis accordingly, but the analysis sequence proposed here should serve as an initial guidepost for the analysis process.

In their study of service value networks, Wang et al. (2015) prescribe an approach for analyzing service value networks which involves defining the objectives of the analysis, then identifying actors in the network, and then determining what interactions exist between the actors. Patricio et al. (2011) prescribe a multilevel service design method in which service concepts are first defined, then the service system's structure is modelled, and finally, the interactive aspects of service encounters are designed using service blueprinting techniques. In both articles, components of what might be considered the system environment are analyzed before components of the system activities. This is simply due to the nature of the architectures: it is extremely difficult to map out and analyze interactions before mapping out and analyzing the actors, resources, and networks which are performing the interactions. With the inclusion of an institutional arrangements architecture, a similar problem emerges: it is difficult to map out and analyze the logics and rules governing actors, resources, and their interactions without first identifying the actors, resources, and their interactions. Therefore, an analysis using the MLSSF should first describe components of the system environment, then describe components of the system activities and how they relate to those of the system environment, and finally, describe components of the institutional arrangements and how they relate to those of the system environment and activities.

The next decision to make in the analysis methodology is which component of the system environment should be analyzed first. Making that decision and identifying specific examples of components within the service system can be facilitated by considering how each component answers a question pertaining to the service system's operation: (1) Who operates the service system? or Who is the focal actor of the service system, or the focal role that is filled by a person who has rights

and responsibilities (fiduciary rights and responsibilities) to ensure the success of the service system? (Actors); (2) What is used to operate the service system? (Resources); (3) How does the service system operate? or What are the value propositions (links in the network) that connect the service system entities, and what are the access rights to resources granted or denied by those value propositions? (Networks).

Depending on the needs of and information available in a given analysis, the “who”, “what”, and “how” questions may have different degrees of importance. Generally, if sufficient information about all three components is available, analyzing actors first will enable easier identification of resources with reference to the basic operational needs of the actors. Similarly, analyzing networks after resources will enable easier identification of networks with reference to basic interaction needs of the actors and resources. In all three cases, considering the bearing of component types and sub-types on the service system will yield a more fruitful analysis.

Progressing into the system activities and institutional arrangements, two more questions should be considered: (1) When does the service system operate? (During interactions and evaluations); (2) Why does the service system operate? or In what circumstances does a service system become established? (Within logics and rules). Analyzing interactions and their types/sub-types after networks enables identification of how the networks are used by actors and resources, and asking the “when” question can be a helpful exercise for identifying specific examples of interactions that exist in the system activities. Analyzing evaluations after interactions allows for a basic understanding to be established of how actors evolve the system by evaluating its performance across iterative interactions. The intentions of actors in evaluating and evolving the systems segues neatly into an analysis of institutional logics. Again, asking the “why” question can be a helpful exercise for identifying specific examples of actor intentions and determining the bounds of their logics. Finally, the logics can be further bounded by analyzing the rules which govern the operation of the service system and impose order upon it.

Components are the traditional foundation of service systems, and a descriptive analysis of a service system can be performed solely with reference to the component and typology layers. However, after analyzing the service system’s institutional arrangements, proceeding upward to analyze at a higher level of abstraction in the architecture layer can trigger new thinking related to the overarching relationships between the architectures. If more than one service system is under analysis, progressing all the way up to the ecosystem layer will also be necessary.

In summary, the prescribed sequence of analysis has 13 steps:

1. Identify the goal of the analysis.
2. Scope the operational boundaries of the service system.
3. Analyze the actors and identify key actors.
4. Analyze the resources and identify key resources.
5. Analyze the networks and identify key networks.
6. Analyze the interactions and identify key interactions.
7. Analyze the evaluations and identify key evaluations.

8. Analyze the logics and identify key logics.
9. Analyze the rules and identify key rules.
10. Analyze the system environment architecture and describe its key features.
11. Analyze the system activities architecture and describe its key features.
12. Analyze the institutional arrangements architecture and describe its key features.
13. If more than one service system is being analyzed, analyze the service ecosystem and describe its key features.

Figure 13.1 illustrates the prescribed analysis sequence by overlaying arrows on the framework's taxonomy. After or during the analysis process, it may also be helpful to use modelling or diagramming techniques to build a better understanding of the relationships among the service system's elements.

### *13.2.5 Applying the Multilayer Service System Framework to a Mining Company*

To test and validate the framework, the analysis was applied to a Canadian mining company using publically available information (Donohue 2017). Mining has typically been seen as a non-service industry; however, as our analysis shows, from a service science perspective, the mining company is a service system in that multiple stakeholders within the organization bring actors, knowledge, resources, and processes together to cocreate value. As an adaptive innovator (IfM and IBM 2008), the organization is the first mining company in Canada, and one of the first mining companies worldwide, to implement CleanTech into their operations by creating an all-electric underground mine (Donohue 2017). Creating an electric mine is beneficial for multiple reasons: the organization receives funding from government incentive programs; their environmental impact is reduced since electricity is a clean energy source and much quieter for operations; batteries change the way machines operate; and, this innovation will completely restructure heating, ventilation, and air conditioning (HVAC) systems underground—giving rise to new infrastructure such as electric-powered heating (Donohue 2017). Most importantly, having an electric fleet will mean that there are no pollutants released underground—making the working environment much safer for workers. Alongside reduction of waste, the company predicts a 20% increase in production once the mine is complete (Donohue 2017). Within the organization, they will break down geographical silos (individual mines) by implementing electricity as an energy source to other mines once the project is complete.

#### 13.2.5.1 Prescribed Application of the Framework

Below, we follow the 13 steps in the prescribed sequence of analysis to analyze the mining company as a service system.

**Table 13.1** Key actors

| Key actors | Role | Description |
|---|---|---|
| Machinery Companies | Beneficiary | Provides machines, installs sensors, analyzes data provided by the mining company to improve operations of the machinery |
| Regulatory Bodies | Authority | Determines constraints (e.g., environmental, jurisdictional) on the ways mining can take place |
| Energy Providers | Beneficiary | Provides energy to the mining company, collects data on energy use, analyzes data to optimize energy use |
| Other mining companies | Competitor | Competes for highly skilled personnel, resources, etc. |

1. ***Identify the goal of the analysis.*** The goal of the analysis is to apply the service system framework to the mining company to test the framework's ability to describe the company as a service system and to show how the analysis can help identify unique aspects of the company and its service capabilities.
2. ***Scope the operational boundaries of the service system.*** The main service system under consideration is the mining organization including its processes, infrastructure, resources, knowledge, and employees. Since the larger context of this analysis considers the company's transition to CleanTech, other service systems within the service ecosystem must be considered when discussing resources, networks, interactions, etc. because it is through these interactions and resource integrations that value is being cocreated.
3. ***Analyze the service system's actors component and identify key actors.*** Actors within the service system associated with this CleanTech project (e.g. the machinery companies and energy providers) can be considered as beneficiaries. By working with the mining company, there is cocreation of value that will result in mutual benefit. Other mining companies can be viewed as competitors—these companies are compelled to improve their performance to preserve their public image in response to CleanTech initiatives (Table 13.1).
4. ***Analyze the service system's resources component and identify key resources*** (Table 13.2).
5. ***Analyze the service system's networks component and identify key networks*** (Table 13.3).
6. ***Analyze the service system's interactions component and identify key interactions.*** Identifying all the interactions (even just the key interactions) within the scope of the CleanTech implementation would not be feasible here; however, in the context of a full analysis, it is necessary to identify all key interactions and possible outcomes. The ISPAR model is a useful tool for analyzing the breakdown of potential outcome results and the range of possible value cocreation outcomes (Maglio et al. 2009). Figure 13.2 shows a sample interaction between the company and three other service systems (regulatory bodies, machinery providers, and energy providers). There are multiple exchanges between the service systems. The company itself is broken down to show one of the many resources—the miners. This is further decomposed into the outcomes specific to the miners. Finally, these outcomes yield value—cocreated with the services

**Table 13.2** Key resources

| Key resources | Description | Operant/Operand | Tangible/ Intangible |
|---|---|---|---|
| Miners, data analysts, business analysts, engineers | Knowledge, skill, competencies | Operant | Tangible |
| Electric-powered mining machines | These mining machines will run on electricity drawn from a battery | Operant (mines for gold) and Operand (acted on by humans) | Tangible |
| External batteries | Used to power the mining machines | Operant (powers the machines) | Tangible |
| Gold | The main function | Operand | Tangible |
| Mining knowledge | Employees have tacit knowledge about mining and machinery | Operant | Intangible |

**Table 13.3** Three key networks within the service system and service ecosystem

| | |
|---|---|
| Value cocreation | 1. Increased mining production from more efficient machinery interacting with the mine<br>2. Consulting service interactions to carefully plan and design for a smooth implementation |
| Governance | 1. Decreased environmental impact measured through digital monitors in machinery to comply with government standards<br>2. Contracts with machinery and consulting service providers outlining terms of service |
| Resource integration | 1. Miners use electric mining machines which decrease pollutants in the mine and creates a safer working environment, data is sent back to the machinery companies<br>2. Data analysts take mining data gathered from machines and suggest new mining processes to improve efficiencies and increase gold output |

provided by the service systems—which benefit many of the service systems. Note that the interactions and resource integrations modelled in Fig. 13.2 are by no means exhaustive.

7. ***Analyze the service system's evaluations component and identify key evaluations.*** For the three evaluation types (quality, productivity, and compliance), multiple actors are invested across more than one of the evaluation types. Table 13.4 shows a breakdown of the key actors and the associated evaluation types. For example, the regulatory bodies are most interested in evaluations of compliance (operational, environmental, data, privacy, etc.)
8. ***Analyze the service system's logics component and identify key logics.*** The variance among logics (intentionality, rational judgement, and bounds on rationality) is too wide-ranging to consider here. It is more practical to assume that all the actors are working with the organization's intentions (Table 13.5). In this scenario, the goal-oriented intentionality is applicable; however, the bounded rationality types are not applicable due to the highly theoretical nature of that element.

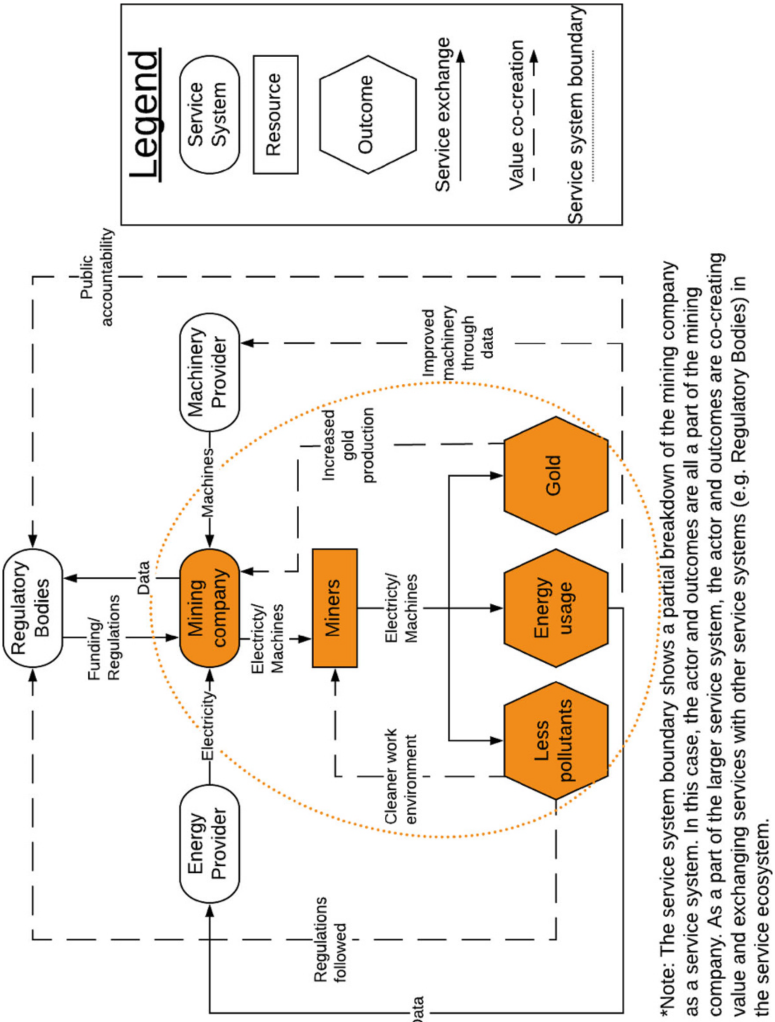


**Fig. 13.2** Interactions within the service ecosystem with a breakdown of actors, resources, outcomes, and value cocreation interactions

**Table 13.4** Key actors and their evaluation interests

| Service systems | Key evaluation interests |
|---|---|
| Regulatory Bodies | Compliance |
| Machinery Provider | Quality, Productivity |
| Energy Provider | Quality, Productivity |
| Consultants | All |
| Regulatory Bodies | Compliance |

**Table 13.5** Actors interacting with the mining company and their logics

| Service systems | Key logics and intentionality |
|---|---|
| Mining Company | Increase mining production, decrease environmental impact |
| Regulatory Bodies | Decrease environmental impact, public accountability |
| Machinery Provider | Increase machinery sales, improve machinery production |
| Energy Provider | Increase energy sales |
| Consultants | Provide knowledge, receive experience |

**Table 13.6** Breakdown of rules within the mining company with examples

| Rules | Examples |
|---|---|
| Laws | Employment contracts, by-laws |
| Rights | Miners given access to data reports compiled by data analysts |
| Norms | Any part of organizational culture (e.g. weekly staff meetings) |

9. ***Analyze the service system's rules component and identify key rules.*** Within rules, there are laws, rights, and norms. Table 13.6 provides examples of these rules. Since the basis of the system and ecosystem is "for profit", many business dealings will be in the form of written formal contracts.
10. ***Analyze the system environment architecture and describe its key features.*** The system environment is very robust with clear distinctions between actors, resources, and networks. Each component answers an important question about the service system's operations and has a comprehensible role within the system environment. The actors and resources are all key features of the environment—which in turn means that the network is also a key component. However, the system environment is described as a combination of static elements which is not the case for the network. The constant value cocreation, governance interactions, and resource integrations would inevitably bring change to those processes (otherwise the organization itself becomes static without progress).
11. ***Analyze the system activities architecture and describe its key features.*** The system activities include the interactions and evaluations. We did not conduct a detailed analysis of the interactions (value cocreation interactions, governance interactions, and resource integration) but described a sample interaction between the company and three other service systems (regulatory bodies, machinery providers, and energy providers). We found it helpful to break down the interaction to show one of the many resources and then decompose

the analysis to a specific key resource in the service system. For the evaluation component of the system activities architecture, we found that multiple actors are invested across more than one evaluation type. The system activities architecture is a complex one that requires significant detailed knowledge of the interactions and evaluations in the service system.

12. ***Analyze the institutional arrangements architecture and describe its key features.*** The institutional arrangements architecture, consisting of the logics and rules, was a useful analysis for determining high level institutional constraints on the actors. For this architecture to have a meaningful impact, the analysis would have to look at actors individually. For example, what logics and rules motivate and constrain machinery providers when installing sensor technology? However, since logics and motivations are different for multiple iterations of the same role it is challenging to map all of the institutional arrangements architecture in this particular case.
13. ***If more than one service system is being analyzed, analyze the service ecosystem and describe its key features.*** The mining company's interactions within the service ecosystem was the main point of focus in this case study. By considering the activities within the ecosystem (not the individual service system activities), it is much easier to envision the interactions, value cocreation interactions, resource integrations, and logics. Each architecture mapped to the service ecosystem level would be extremely useful to understand a case study such as this one.

### *13.2.6 Reflection of the Process and the Results*

An overall analysis surrounding the key features of the environment, activities, institutional arrangements, and ecosystem provides the analyst an opportunity to bring together the different components to consider how they function together. As shown above, it also provides a platform for reflection about the ease of recognizing the different components and their cohesion with the other components. We were also interested in evaluating the MLSSF for analyzing non-traditional service organizations (such as a mining company) as a service system. In the context of this service system, some of the components (and thus the architectures) were difficult to assess. Many of the resource integrations and collaborations under focus were among two or more different service systems (actors) and not within the mining company. This is an important point to note because it shows how much value is being cocreated within the ecosystem. This also suggests that some of the important aspects to consider when analyzing a non-traditional service organization are the ways in which it is situated within an ecosystem and so a focus for analysis should be at the ecosystem and system layers.

## 13.3 Conclusions and Future Development

A Multilayer Service System Framework for analyzing organizations as service systems was presented. The application of the MLSSF to a mining company identified the several suggestions for future development of the framework. The relationships between elements could be explained in greater detail and perhaps visually mapped out so as to better illustrate their significance. This is especially true of the interplay between institutional arrangements and all of the framework's other architectures and components—institutional perspectives have been addressed in the service science literature only recently, and the full extent of their relationships with other service system elements is not yet fully understood. As the state of the literature progresses, more detailed models of the relationships between institutions and service system elements may arise, and those models could be considered for integration into the MLSSF.

Practical applications of the framework to case studies are needed to further validate its ontology and methodological prescriptions. The findings of the case studies can then be used refine the framework.

There are many opportunities for this framework to evolve from prescriptive to evaluative. One way is to incorporate the idea of turning services and data into value and providing soft benchmarks for organizations to compare. The Lim et al. (2018a) data framework provides a good starting point for this objective by looking at the taxonomy and breaking down how value is created from data. By combining ideas from the MLSSF and the data framework, organizations could be evaluated on their position as a service system within a service dominant landscape as well as the efficiency and effectiveness of their data-intensive services.

In keeping with the ethos of service system framework, future literature reviews will need to be conducted periodically to develop evolutions of the framework and its relevancy to emerging trends.

We also identified areas for future research in service science. There is an opportunity for future studies to better demarcate and understand the boundary between service systems and service ecosystems Other areas for future research on service systems include understanding the ways in which different reasoning affects logics and intentions in service systems and understanding how evaluation leads to evolution in service systems. Finally, an area that remains unexplored is a study of range of governance outcomes and resource integration outcomes in service systems.

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# Chapter 14
# People and Social Interaction: Drivers of Service Innovation

**Cheryl A. Kieliszewski and Laura Challman Anderson**

**Abstract** Building an understanding of service innovation and how to foster it continues to be an important topic to academics and practitioners alike. This chapter examines service innovation from the vantage point of the service team. We introduce a research framework utilizing digital trace data from service team interaction and activity system analysis. An example research scenario illustrates the application of the research framework using email, meeting transcripts, and system application logs to work towards a broad and more real-time perspective of team interaction to identify innovation. We note that changes in the ebb-and-flow of service team activity and the appearance of unique signals may be a starting point. The challenge is to determine which metrics in the analyses are representative of innovation and how to automate the aggregated view to create a timeline of activity that will identify the emergence and impact of innovation. Future research opportunities include automated activity system analysis, the development and validation of metrics to measure service innovation, and the incorporation of an economic perspective.

**Keywords** Service innovation · Interaction · Trace ethnography · Cultural-historical activity theory (CHAT) · Activity system analysis · Service team · Service system · Information sharing · Socio-technical system · Service science

## 14.1 Introduction

There is a growing desire among both service providers and academia to understand how to foster service innovation. Successful service innovation requires effective participant interaction across heterogeneous boundaries to create new and purposeful service offerings. However, the challenge for a firm is to recognize and capture

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_14

the full potential of innovation and apply it at a scale beyond an individual offering or team. This chapter is motivated by the opportunity to scale the study of social interaction and human activity in service using digital trace data analyses with the goal of identifying and enhancing service innovation.

To do this, we examine the service system abstraction, focusing on ‘people’ and their individual and collective activity across the dimensions of a service system (configurations of people, technology, value propositions, and shared information (Maglio and Spohrer 2008)). We first discuss the emerging importance and perspectives towards studying service innovation. Second, we describe our analytical framework which provides a consolidated viewpoint to integrate the foundations of service systems with cultural-historical activity theory, activity system analysis, and data sources. Third, we provide a research scenario and approach based on our experiences. Finally, we discuss what we've learned about the framework and its potential for understanding service innovation through social interaction at the scale of an enterprise.

## 14.2 Background

Service innovation is a principle topic in service science, and its emerging importance is noted by multiple authors. In reviews of service system analyses, Lyons and Tracy (2013) and Frost and Lyons (2017) highlight the importance of service innovation and recommend an examination of the typologies of innovation. This is not the first that service researchers have identified the study of ‘innovation’ as important. Ostrom et al. (2010), in their examination of research priorities for the discipline of service science, also identified innovation as a priority. In addition to service innovation, Frost and Lyons (2017) suggest further focus is needed on ‘people’ aspects across the dimensions of a service system. They emphasized clarifying the characterization of stakeholders and entities, identifying how stakeholders measure performance, and using a sociological perspective to examine resources. Understanding how human activity affects innovation is a grand challenge that does not pose a simple solution or method of examination.

The study of service innovation is nascent and has yet to be grounded by a body of research to better understand and demonstrate its impact on the differentiation and advancement of an organization. Durst et al. (2015), conducted a literature review to examine the measurement of service innovation at the level of the firm. In their paper, they state that service innovation “. . .has become a term referring to innovation taking place in the various contexts of services, including the introduction of new services or incremental improvements of existing services” (p. 66). What they found was that there is no common definition or consensus for the study or measure of service innovation. This is in agreement with findings by Witell et al. (2015) where, in their paper to identify the key characteristics of service innovation, they identified three perspectives that the literature clustered into. The primary difference between the three perspectives was the enactment of the service (i.e., degree of

relationship during the crafting of the service with the customer, marketplace, or world). However, they also found two commonalities across all three perspectives for the requirement of 'newness' (whether an incremental or radical change) and inclusion of both product and process as aspects of a service innovation. Lusch and Nambisan (2015) also grapple with the dilemma of a comprehensive characterization of service innovation. They propose service innovation be grounded in service-dominant logic and essentially embedded in the collaboration of an actor-to-actor network. Their collaboration-centered conceptualization resonates with our people-centered examination of service innovation. Based on the evolution of perspectives and to paraphrase Lusch and Nambisan, we're adopting the definition of service innovation as the bundling of new and/or existing resources to create novelty that is beneficial to actors in a given context.

Building on our definition, we'd also like to know how service innovation is being evaluated. Common themes from the Durst et al. (2015) examination were that the measures for service innovation are different from product- or goods-based innovation; and, that focus on the process characteristics of service innovation may be more applicable to intangible, multidimensional relationships that are inherent to a service than the technical (products-based) aspects of the service. In addition, the use of nonconventional data sources, such as social media, was thought of as useful in understanding innovation at the firm level. In a study about service innovation patterns, Hertog (2000) emphasized the importance of knowledge and information exchange to drive service innovation. This can take the form of tacit or local knowledge that is important for the service context. The exchange can also be seen as a context for a learning experience, and one which can be transformative toward innovation. Given these views on the need to treat the study of service innovation differently than that of goods innovation to reveal the intangible aspects of relationships and knowledge exchange, our suggestion is to examine the interactions of the people who comprise a service team as the cocreation of a service unfolds.

### *14.2.1 Value Cocreation*

Within service science, the constructs of value, value cocreation, and value realization are early, debated, and standing tenets based on the shift from goods-dominant logic to service-dominant logic to enact a service (Spohrer et al. 2007). Working within the definitions proposed by Vargo and Lusch, we are adopting the following for each construct. First, value is created through the integration of resources that are afforded by configurations of actors. The trickiness of this definition, is that the actors may not be aware of each other (2016). An actor can be an individual, organization or entity, or society. Next, value cocreation is the actions of multiple actors that contribute to each other's wellbeing. The actions are characterized by specialization and interdependency (2016). The primary activity of value cocreation

is resource integration (2017). Lastly, value realization is the outcome of value cocreation (2016).

With value realization being the final evaluative criteria of value cocreation, we beg to ask how does one know if they're on a path of value cocreation? The intangibility of cocreation by individuals (or larger entities or society) makes it difficult to observe or measure in practice. However, to overcome this invisibleness of intangibility, engagement and interaction has been proposed as a proxy to examine the multi-actor impact of people's actions in the service system (Storbacka et al. 2016). Recognizing that actor engagement in studies of service ecosystems has primarily focused on customer engagement, Finsterwalder (2018) points out the importance of broadening that perspective to consider engagement of all actors and resources in the service ecosystem. This work aligns with a review of theoretical and empirical research performed by Brodie et al. (2011) who provide a general definition of customer engagement within the context of service relationships and service-dominant logic. They argue that customer engagement is considered to be a multidimensional concept that reflects a customer's context-dependent interactive cocreative experience with a firm or brand and has antecedents of involvement and participation.

The work by Brodie, et al. starts to push the boundaries of market and service thinking regarding the customer through their general definition and five foundational principles. However, Finsterwalder calls for greater generalization of engagement to embrace recent service-dominant logic thinking (i.e., Vargo and Lusch 2016) to analyze the actor-to-actor relationship. He proposes to dissolve the firm-customer divide within current engagement definitions and adopt the notion of 'actors' which could be people or other resources, to treat engagement as an encompassing construct that represents both psychological/receptive properties and behavioral/transmissive properties of actors, and that the properties evolve from interactive processes among actors. These evolving perspectives around engagement and value cocreation express a need for both theoretical and empirical experimentation to better understand how to determine and measure the constructs being proposed. To work towards an examination of engagement and cocreation, we take these ideals and narrow our focus upon a service team.

### *14.2.2 Service Team*

Individual participant actors connected with a service, collectively having many different roles and responsibilities, come together to perform activities in the rendering of the service and the creation of value. In a service ecosystem, these participants include members who represent multiple stakeholders (e.g., both the provider and the client) as potential collaborators within a relationship. The combination of stakeholder participants comprises a 'service team'. The reason for the introduction of 'service team' is to identify a boundary of membership that can be examined. As such, we assume that the service team resides within a larger service

ecosystem (which could also be conceived of as the boundary for membership). Without such a structural element, regardless of expansiveness, it is difficult to know the delimiter for study and interpretation.

The human force driving service innovation manifests through social interaction that spans the boundaries of participant diversity, including culture, experience, and discipline, among others, marked by engagement through information sharing and knowledge integration (Ordanini and Parasuraman 2011). In the study of service delivery there is broad agreement about the importance of social interaction and people as contributors and participants (Immonen et al. 2018; Fliess et al. 2014). This is true across the range of service channels from technology-mediated to human-human settings, with interaction being of key importance in value cocreation (Immonen et al. 2018). Also to be taken into consideration is that teams composed of members with different expertise and experiences create more innovative solutions than teams composed of more homogeneous membership (e.g., Lungeanu and Contractor 2014; Nielsen et al. 2017). Extending this notion to a service team, people of different disciplinary, motivational, and cultural backgrounds and the resources they bring are expected to come together and interact through cooperation and collaboration to cocreate something of value. Cocreation by the service team appears simple on paper, yet as many of us have experienced in tasks such as co-authoring a paper, facilitating a committee to agree upon a set of objectives, or a society adopting changes to improve circumstances, it can be very challenging.

The interaction patterns of team members (e.g., sharing of information, finding common ground) have been found to be important in realizing innovation outside of service science, which can be used to inform examination of the service team. Literature that examines the work of teams, particularly from the computer-supported work, management, and computer science perspectives, explores a breadth of human and technological factors of teamwork using a range of research methods. These examinations seek to understand the ingredients of good teamwork, with the implicit expectation that facilitating good teamwork will optimize outcomes such as innovation.

Traditional research methods to examine teams include observation, interview, case study, field study, artifact analysis, and survey. The human and technological factors of interest examined using these methods range widely from trust to coordination to collaboration amongst team members under different circumstances. Examples include, Al-Ani et al. (2013) use of interviews and grounded theory to demonstrate that the gradations and expectations of trust are central elements in distributed teams. Acclaimed researchers Olson and Olson (2000) conducted field and laboratory studies to examine team coordination and the impact of geographic distance on teamwork. Lastly, research by Hoegl and Gemuenden (2001) to examine the quality of interactions within a team (communication, coordination, balance of member contributions, mutual support, effort, and cohesion) using a fully standardized questionnaire with 145 software development teams.

## 14.3 Research Framework

Up to this point, we have discussed the vagueness of service innovation in the service research literature along with thoughts on what influences innovation and how it could be studied. In this section, we propose a framework that is grounded in activity theory and supported by activity system analysis and trace ethnography methodologies to examine cocreation and service innovation through team member interaction as patterns of information sharing, knowledge integration, and community engagement. The analyses illuminate systemic contradictions or tensions, temporal evolution of work activities, influential roles, and the formation of and changes to team interaction. The output of the framework is a proposed proxy to understanding the innovative process through examination of the organic products and byproducts of service team cocreative activity and the work being performed.

### *14.3.1 Activity Theory*

Activity theory, also referred to as Cultural-Historical Activity Theory (CHAT), is a descriptive transdisciplinary theoretical framework (Engeström 2000). The theory provides a framework for understanding the interactions and interplay among people, objective of an activity, tools and mediating artifacts, and outcome in work, social, or historical contexts. It simultaneously enables analysis at the level of the individual and of larger collections of people and institutions (Engeström 2008). We are not the first to propose the use of activity theory to examine the service domain. The theory is commonly used to unveil contradictions, disparities, or tensions within a complex system to identify opportunities for change, growth, and innovation.

For example, Eppich and Cheng (2015) discuss the use of activity theory applied to simulations and debriefings in a multidisciplinary healthcare service setting. The application of activity theory here provides focus on the work context, which is important for a deeper understanding by the participants and their capability to see multiple perspectives on a complex, dynamic situation (in this case, the emergency room of a hospital). The theory is used to help deconstruct a complex situation to gain an understanding of the social dynamics and discussions of stakeholders for improved patient care. Alternatively, Oliveros et al. (2010) examine power dynamics and activity system contradictions for higher education service encounters. In their examination, application of activity system analysis found contradictions and issues that revealed lack of clarity and coherence in processes, inflexible bureaucratic rules, and a fragmented division of labor. In this example, activity theory was used in a reflective manner, aiding the institution in identifying and determining where improvement is warranted. The analytical approach in which the constructs of the theory are examined to gain insight is known as activity system analysis.

**Table 14.1** Mapping of parallel structural elements of a service system to an activity system

| Service system | Activity system | Description of the parallel structural elements |
|---|---|---|
| Shared Information | Tools/Artifacts | Objects or resources used to communicate and mediate understanding |
| Technology | Tools/Artifacts | Resources used to mediate and/or enhance a function |
| People | Subject, Division of Labor, Community | Individuals or aggregation of people into meaningful groupings |
| Value Propositions | Object | Intention, purpose, goal, scope, or target of an activity |
| Laws | Rules | Principles, regulations, or controlling influences that govern systems |

### *14.3.2 Activity System Analysis*

Activity system analysis is ideally suited to the analysis of service innovation because of the structural parallels between activity systems and service systems. Each system is built with elements that are then defined and objectified to create a meaningful structure (Table 14.1). In general, each system includes an element that is emblematic of governance (laws and rules), goals or objectives (value proposition or object), actors (people or community), and resources (tools/technology, information, or artifacts).

As such, the components of an activity system can then be used to apply activity system analysis to a service system to illuminate contradictions such as a personnel gap, problems with the operation of a tool (such as computer system or other technology), or even differing views about the object of a service or a portion of a service (such as value proposition). A contradiction provides an opportunity for change and/or innovation. For example, the adoption of a new tool in a service delivery context might require new knowledge and learning in order to use it effectively. This knowledge gap or changed way of working would surface in an activity system as a contradiction, identifying the need to improve or implement training.

In addition, because this analysis can be done on multiple levels of system abstraction, it is a powerful tool to examine a complex service system. For our purposes, activity system analysis affords a way to compartmentalize the service team and their work into system components relevant to our research as software applications, communication channels, transcripts, and presentations (tools and artifacts), organizational affiliation and roles (subject and organizational structure), milestones and goals (objects), and scope-of-work and agreements (rules).

### 14.3.3 Information Sharing and Knowledge Integration

Recently, new data sources and data collection methods are starting to be used to understand teams, and they show promise as an expansion of traditional observation- and recall-based methods. Woolley et al. (2010) experimented with small, two- to five-member work teams who had to perform a variety of group tasks. Notable in this work were the findings that team performance was most impacted by team composition and the way group members interact when they assembled. To expand on this research, Pentland (2014) states that after additional examination of the data used in the Woolley et al. study, "the pattern of idea flow by itself was more important to group performance than all other factors" (p. 89). Research performed to examine the complex connections and interactions of teams composed of people with diverse backgrounds, such as that performed by de Montjoye et al. (2014) and Pentland, has found that strong networks, gauged by information and idea flow within and outside of a team, are a key factor in increasing performance and innovation. Core to their investigations have been social network analyses from which a degree of information sharing and idea flow is inferred.

Information sharing and knowledge integration has been extensively studied over the past decades, often with a homogeneous population and with a particular emphasis on specific contexts such as the academic environment, healthcare setting, virtual team configuration, or of engineers (Sonnenwald 2007; Fidel and Green 2004; Talja 2002; Ellis and Haugan 1997). The challenge of knowledge integration in heterogeneous, interdisciplinary teams has recently become a focus of study, as this type of team composition has become more prevalent in everyday work and play (Salazar et al. 2012). How information sharing and knowledge integration develops within a heterogeneous team with members of varied backgrounds and expertise (Hsu et al. 2014) may be a key to successful cocreation and innovation within the context of service offerings (Kieliszewski et al. 2014). We assert that this call for examination of people-centric activity and social interaction within a service team, and the emergent nature of the interactive processes requires the application of approaches such as activity system and trace data analyses.

### 14.3.4 Framework for Analysis

You may now be asking: how would someone actually use activity theory and activity system analysis to examine service innovation? Fig. 14.1 provides a conceptual framework for its use. First, because we're interested in using digital trace data as a source of information to identify service innovation, the data underlies the foundational components of the activity system. With increased digitization of our everyday activities, working with digital data and associated analytical methods to examine human behavior are helpful. Trace ethnography, utilizing digital trace data sources, is one of these methods. It is a retrospective approach that combines the

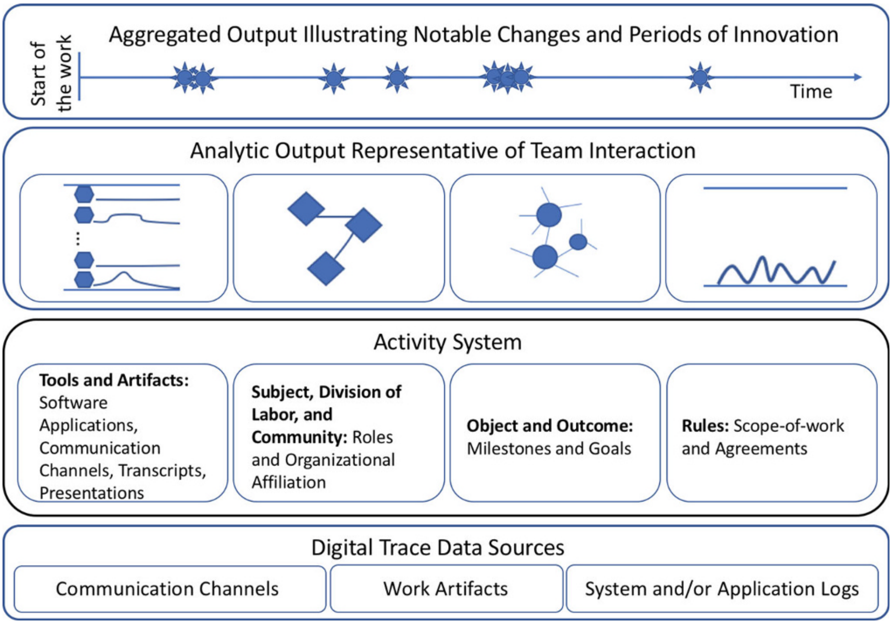


**Fig. 14.1** Illustration of the analytic framework where the levels build upon and inform the next upper level of analysis and understanding upon a foundation of digital trace data

methods of participant observation with analysis of system log data to reconstruct the patterns of activity and practices of users in socio-technical systems (Jackson et al. 2018). Trace ethnography affords researchers an opportunity to examine actions and practices of participation and interaction captured in computer systems (Geiger and Ribes 2010). This ethnographic approach has led to new knowledge of human behaviors most commonly in online systems (Geiger and Ribes 2011; Welser et al. 2015). A variety of digital source data can also be mapped into the activity system model for analysis of the individual and collective work activity of actors within the service team and technology resources.

The next layer up is the activity system analysis which is key to differentiating structural elements of the system and aligning the data with element types. The system provides a standard structure for examination of a complex system, with many moving parts, to see patterns or anomalies that may be contradictions. Recall, contradictions within an activity system provide opportunities for change, growth, and innovation.

- Tools and artifacts augment our human capabilities in our personal and work lives. They allow us to be efficient in our work (e.g., the use of a word processing software to compose a paper) and in our communications with others (e.g., telecom, video, email, messaging). The digital tools and artifacts are a form of mediation between individuals and groups that help people negotiate perspectives through the exchange and capture of information, knowledge, and ideas.

- The grouping of subject, division of labor, and community is all about the people in a system: the individual person performing a role, working in concert with others on a collective activity and supported by a larger community including stakeholders. Subject refers to an individual person whose perspective populates the other elements of tools and artifacts, object, and rules. Division of Labor is how the work is divided up. Community is a general grouping of people, who may be only indirectly involved in the activity at hand.
- Object is the objective of the activity or the goal of the work effort, whereas the Outcome is the interim or final result of the activity.
- Rules provide guidelines for the activity, with specific examples that include legal contracts, agreements, and laws.

Moving up the diagram, the analytic output is representative of the different types of analyses that can be performed on the data within the context of the activity system. In this paper we hint at analyses such as network, content, and system log. However, we do not view these as all-inclusive of how the data could be examined. Lastly, the top layer of the diagram is an aggregation of the analyses as a timeline and longitudinal view showing changes in activity as it is performed. In summation, utilizing digital data within the activity system model provides a data-driven view of a complex system and the chance for new insights about innovation.

## 14.4 Examining Service Innovation: Example Research Scenario

As day-to-day work by service professionals becomes increasingly embedded in computing technologies, digital traces generated as a byproduct of individual's interactions brokered through computer systems offers a new data source for examining interaction within teams. Social interaction of team members can be captured through the many communication modes they use. These communication modes range from face-to-face, telephone, video, text, mathematical formulas, and/or programming code. Conversations as one-on-one or group meetings, chats on instant messaging or texts, correspondence through email, threads in social networking platforms, or contributions to a code repository can be used as recorded evidence of interaction.

Use of many of these modes results in a digital capture (or trace) of the communication as structured or unstructured data (i.e., a rigidly defined data format (database structure) or fluid undefined data format (human language), respectively). The collection and use of trace data is not new. It is commonly used in applications to illustrate, measure, and recommend social networks, and is a backbone to networking technology organizations such as Twitter, Facebook, LinkedIn, or Academia.edu.

Trace data is also starting to be collected and used within businesses through enterprise social networking (ESN) platforms. For example, Viol et al. (2015) have

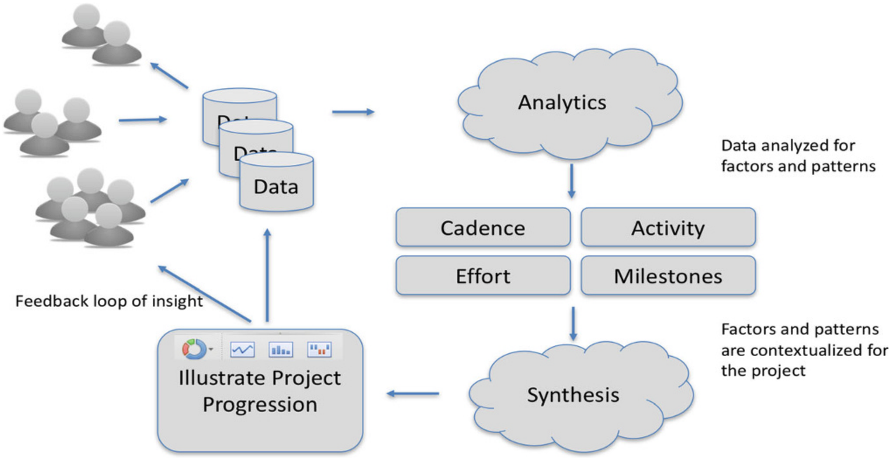


**Fig. 14.2** Approach to the empirical study of the digital trace data of teams

examined a service firm's ESN data to determine knowledge flows through user behavior metrics. They want to use ESN data to help improve organizational knowledge transparency in service firms—that is, who knows what in an organization—through the identification of knowledge actor roles and identifiable behaviors. A broader study by Friedman et al. (2014), examined ESN data at Alcatel-Lucent to explore if such a technology breaks down organizational and geographical barriers. One of their insights for future research is to analyze such data to enable automatic detection of innovative ideas that are posted via ESN threads and blogs. These are two examples that use one type of digital trace data to examine organizational structure, communication, and idea flow. Both studies warn against the over reliance on social network data as being fully representative of what is happening within or across teams, but that it is a piece of information that can be used with other data to better identify interaction and idea flow.

As such, we have been investigating the use of digital trace data from team's work activities to provide insight into team interaction and innovation. In general, the approach that we have pursued is a simple idea, yet a challenge to implement and study. The idea is to collect digital trace data from multiple sources, prepare the data for analysis, apply analytics of interest, gather measurement output of interest, synthesize the output into a meaningful representation of team interaction, and provide feedback to the team regarding progression towards innovation (Fig. 14.2). The objective is to be able to automate this sort of analysis for immediate feedback to the team for any sort of course correction on their part with respect to objectives or milestones, and to be able to perform the analysis at enterprise scale to gauge progress of multiple innovation teams. A description of each of these steps in detail is beyond the scope of this chapter and we refer the reader to some of our previous work in Anderson and Kieliszewski (2015, 2018). What we will do is provide a summary of our investigations that includes data sources, analyses, and

findings in the rest of this section and then provide a discussion of implications for service innovation and service research in Sect. 14.5.

The teams we have studied work in the business services industry and are groups composed of data scientists, software engineers, researchers, and subject matter experts who are representative of both the provider and client as a service team. As such, a cocreative relationship is established to determine the value proposition of design, implementation, and delivery of the service; and the ways in which the innovation can be used as a service offering. The relationship is usually collaborative and iterative with actors engaged in both independent and intersecting activities over time.

To investigate innovation, our first and most formidable challenge has been identifying and gathering the trace data that exists in separate and unrelated systems. (This was also a challenge expressed by Viol et al. (2015) and Friedman et al. (2014).) In the enterprise setting, email continues to be a common avenue of communication that yields both unstructured and structured data that can be examined for topics and evolution of conversation along with frequency, density, and direction of interactions amongst and outside of the team. Yet, any single data source, such as email, has its limitations to capture the whole story of team activity or innovation. To work towards getting a broader and more real-time perspective of team interaction to identify innovation, we've also collected and examined meeting transcripts and logs from compute and application systems using trace ethnography, communications threads of email and an ESN system using social network analysis, and structured and unstructured text within project artifacts and communications using natural language/textual and concept analyses.

In general, we have been able to see aspects of interaction over time that may seem like obvious indicators. These include trends of concepts and conversational themes through their emergence, convergence, crescendo, and decay over time; and interaction seen through changes in sociogram membership, structure, and output metrics such as degree and betweenness centrality that indicate interconnectedness of team members. Our findings also illustrate early patterns of involvement differentiated by roles and activities, conversational themes, and the interconnectedness of individuals on a project (Anderson and Kieliszewski 2018). In addition, we have explored other digital trace data sources that may seem a little less obvious as indicators of innovation. In particular, we've looked at the potential usefulness of changes in software application use found in system logs (Jackson et al. 2018).

Each type of analysis yielded interesting results on its own. For example, through the sociograms we were able to see general increased evidence of participation and interaction by all participant roles as a team progressed from starting to fully executing to closing the work. This itself is not surprising or an ingenious research finding, in fact it was expected. However, when overlaying analyses (e.g., sociograms, content, application use), we were able to readily identify periods when conversation became intensely focused with participants from different backgrounds converging on the same topics and using the same terms; also, when individuals and aggregated participant roles were either absent or had exceptionally high representation. These were the periods that caught our attention and where additional data

analyses and sources were helpful in determining if something was amiss or going very well.

We also found that there were catalysts of movement towards innovation. That is, through the data, we could see what looked like ordinary ebb-and-flow of progress that included a regular set of team members and expected topics of conversation with respect to objectives and approaching milestones. Yet, less seldom, we could also see a build-up of activity across all analyses that provided signals of something unique emerging from the team. Changes in measurements from the analyses that identify ebb-and-flow and unique signals may be a starting point to measure service innovation at the team level that can be extrapolated to the firm level. The challenge becomes determining which metrics in the analyses are representative of innovation and how to automate the aggregated view to create a timeline of activity that will identify the emergence and impact of innovation.

## 14.5 Discussion

As previously mentioned, what leads to successful service innovation across contexts is not well understood, and the mechanisms to understand service innovation through identification, capture, and measurement of key indicators are also at an early stage. This is because service innovation is thought to be essentially different from goods-based innovation and the same measures of invention and differentiation may not apply. Instead, measures of process and relationship may provide greater insight into the production, support, and economy of service innovation. The approach we're advocating provides a way of examining service innovation from the vantage point of the people within the service system—individually and collectively—whose innovations ultimately impact the firm and what it is able to deliver to its clients and the general marketplace.

We detailed our research framework that is built on a methodological foundation of activity system analysis, which is grounded in activity theory, to conceptualize, organize, and analyze data produced as a byproduct of the service work itself. We also described the purpose of examining the details of social interaction and human activity in a service system with the goal of understanding and supporting service innovation. Lastly, we provided an overview of our experiences from the application of the framework in a specific research scenario. We now look at the implications and relevance of a broader application of the framework to address gaps identified in the literature, the benefits and challenges of using this approach, and how this all relates to both theory and practice to move the understanding of service innovation forward.

The analysis of organic activity and interaction to identify cocreation and innovation is a new vantage point that enables reflection on a wide set of work dimensions by the service team members, from building shared understanding, identifying activity, gauging expected progress, and ultimately resulting in enhanced team performance towards innovation. The service context varies and is composed of

configurations ranging from persistent (e.g., a business unit within an enterprise) to ad hoc (e.g., technology designers and programmers coming together for a hack-a-thon challenge) system arrangements. It is important to be able to understand all configurations in value cocreation across networked actors (e.g., provider-customer, provider-provider, customer-customer) in order to normalize the impact of innovation. Use of the proposed research framework would provide a differentiated view across all of these combinations.

The proposed framework maps the constructs of a service system to an activity system. This mapping enables the use of activity system analysis to examine the service system for contradictions that afford change and innovation. Grounded in activity theory, as the theoretical framework, the complexities of a service system can be represented and examined at the broadest ecosystem level down to the most granular individual contributor or resource level. It is important to be able to capture the details of what is happening at ever expanding degrees of complexity from the service encounter, service network, or service ecosystem, and have the capability to maneuver through systemic complexity. Activity theory provides the capability to examine the context and data at multiple levels. The 'people' construct in a service system is manifested in three different ways in an activity system: as an individual person (subject), within a context in the subdivision of work (division of labor), and collectively in a larger service ecosystem (community). The manifestations can be examined through data that is a byproduct of existing actions in each context. Looking at the service research literature and it's features that are included in this chapter, we start to see a structure that aligns the study of service innovation with the elements of the service system and activity system analysis (Fig. 14.3). For the purpose of this chapter, the emphasis of the literature features is on the examination of interaction, engagement, and activity of people.

Building an understanding of both the failures and successes of cocreation based on interactions and engagement of individuals or organizations is important to understanding service innovation. Traditionally, research into interaction and engagement has utilized methods such as interviews, ethnographic observation, and self-reporting mechanisms, but alternative approaches are needed which reveal the dynamics of intangible factors in complex systems. Similar to emerging research in the areas of team science and social physics, examination of trace data sources from communication channels such as email, ESN platforms, and meeting transcripts are enlightening. The examination of trace data has allowed us to identify service team interactions, exclusions from team discussion, and how clusters of communities emerge and disperse. These data also afforded insight into chatter, discourse, concerns, and progress unfolding over time that could be integrated into a model of service innovation.

With the potential to use digital trace data sources to identify service innovation, there are some general challenges to note. The data collection and analysis that we have performed has been very laborious and required expertise in the areas of database and system log design, data cleansing and formatting, and analytics. Some of the digital trace data is contained deep in system logs (e.g., web application logs), is not located in one repository or technology system, and can require

| Service System Components / CHAT / Activity System Analysis | People (Actors) / Subject, Division of Labor, Community | Shared Information / Object, Mediating Artifacts, Rules | Technology / Tools and Technology | Value / Outcome |
|---|---|---|---|---|
| **Service Research** | • Stakeholders [1]<br>• Entities [1]<br>• Customer [9]<br>• Teams [10] | • Access rights of resources [1]<br>• Compliance measures [1]<br>• Performance measures [1]<br>• Service level agreements [3] | • Information technology service management [3]<br>• Role of technology [4]<br>• Informatics and big data [5,6]<br>• Smart service systems [5,7]<br>• Accessibility [8] | • Typologies of innovation [1]<br>• Service ecosystem [1,2]<br>• Value networks / value constellations [3] |
| **Potential Data Sources to Identify Service Innovation** | • **Synchronous and asynchronous communications:** email, enterprise social network, instant messaging, texting, telecom, video, recorded person-to-person meetings, tweets<br>• **Imbedded work technologies:** system logs, application logs, sensors<br>• **Knowledge portals:** wikis, blogs, websites<br>• **Governance / Formalized structures:** contracts, agreements / compliance, rules, laws<br>• **Work artifacts:** documents, code, recordings (image, video, audio)<br>• **Business processes:** project plans / milestones, organizational structure, | | | Support for Identification of:<br>• Contradictions<br>• Expectations<br>• Engagement<br>• Idea Flow<br>• Value cocreation<br>• Innovation |

[1] Frost and Lyons, 2017; [2] Demirkan, 2013; [3] Alter, 2011; [4] Ryu and Lee, 2017; [5] Ouyang, et al., 2017; [6] Mainardes, et al., 2017; [7] Maglio and Lim, 2016; [8] Immonen, et al., 2018; [9] Brodie, et al., 2011; [10] de Montjoye, et al., 2014

**Fig. 14.3** Key ideas from the chapter that represent the mapping of service system and activity system elements to data from human interaction as an input to service innovation

extensive parsing and formatting. Software and data architecture and engineering expertise is needed to obtain and prepare the data and process it for analysis. There are also challenges around privacy and use of digital trace data to examine individual and entity activity that needs to be addressed as more of these sources become available. We worked with individual teams and were able to reassure them through example of how we collected and used the data. It is a greater and different challenge at an enterprise- or service ecosystem-scale to do the same.

In addition to the stated challenges, there is opportunity for future research and development to employ the examination of people's activity to inform service innovation. In particular, automated activity system analysis methods do not exist to organize and rationalize the analysis of the data. Additionally, the identification and development of metrics that measure service innovation are first forming and more research is needed to validate them across service contexts. Lastly, we are not economists and as such, we have not presented an economic perspective in this work. The ideas and theoretical approach to understanding service innovation may be improved with the addition of being able to solidly quantify the aspects of innovation to then better understand its monetized value. This would allow for a more accurate measure of innovation potential and final impact upon firms engaged in cocreation, which in turn could be used to identify emerging or unforeseen areas of opportunity.

## 14.6 Conclusion

Information sharing and knowledge exchange are particularly powerful in driving new ideas. The use of digital data sources, created directly from the service activity, can be used to provide insights on the service work and signposts of innovation. Digital messages as proxies for communication and interaction and digital footprints left behind through the use of pervasive automated systems provide direct evidence of human activity in the service system. The use of activity theory and application of trace ethnography provides the capability to capture, aggregate, and analyze what people are doing together and individually. Application of analytical methods on the digital data, such as social network and unstructured text analysis, enables a composite view different from more traditional data collection and analysis methods. Additionally, the possibility to collect and analyze data over time, enables a time series view of multiple aspects of the service work. Ultimately, the capability for continuous, instrumented, integrated and minimally labor-intensive capture and analysis of service system data would yield insights about the reality of the service context, and provide markers to guide innovation in the service system.

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# Chapter 15
# Queues in Service Systems: Some Unusual Applications

**Luna An, Mallika Machra, Abigail M. Moser, Sanja Simonovikj, and Richard C. Larson**

**Abstract** Queues can exist in unusual places, often very different from the traditional standing line of customers. Here, we visit some of these less obvious queues, some fun and some quite serious, with the intent to open our eyes to the fact that at any given time, each of us is waiting in multiple queues. Our tour of queues includes: (1) the Hypercube Queue model for emergency services such as ambulance and police services; (2) queues of PhDs waiting as postdoctoral fellows, hoping to obtain a tenure-track faculty position; (3) a university's faculty as a large queue, where "service" is leaving the academic ranks; (4) queues of moving cars trying to find inexpensive on-street parking in cities; (5) queues of homeowners waiting for the restoration of electrical service following a Nor'easter; (6) queues of individuals awaiting human organ transplants; (7) human behavior in queues, often with culturally dependent rules for behavior; and (8) smart phone apps for managing or avoiding queues.

**Keywords** Queues · Waiting · Emergency response · Post-docs · Queue psychology · Queue culture

## 15.1 Introduction

Virtually all service systems have queues. Traditionally, a queue is a line of standing customers waiting for service, and the queue exists because near-term demand for service exceeds real-time capacity to provide service. A system's queue performance is usually a major factor in users (e.g., "customers") evaluating total system quality.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_15

In our experience polling young adults, even one bad queue experience at a service provider can result in the customer's lifetime pledge never to re-patronize that provider. Many years ago, such an experience caused the senior author of this chapter to never re-patronize a major national box store, and in fact to initiate a new path in his career—the psychology of queues!

Queueing theory was born in Denmark in the period 1909–1915. The then-new Copenhagen Telephone Company asked young electrical engineer A.K. Erlang to develop some scientific/engineering methods for determining the needed capacity of the new central telephone switch. Imagine the new invention of the telephone going to a general network configuration, so anyone with a phone could—with human operator assistance—call anyone else. It was a hub-and-spoke system, the spokes being the wires connected to the central station and the hub being the central "switch" at the station, where operators would make the desired connections. If the hub capacity were created larger than needed, there would be very few connecting queue delays, but the company would have spent more than necessary for a major capital investment. Not good for financial stability in an emerging market. If the hub were to be made smaller than needed, queue delays and lost calls could become regular occurrences, perhaps so bad that customers would attempt to make lifetime pledges never to use a telephone.

Using engineering approximations to make the mathematics tractable, Erlang invented queueing theory. His most utilized model, even to this day, is the Markovian *M/M/k* queue, meaning *M*emoryless (Poisson) arrival process, *M*emoryless (negative exponential) service process, *k* identical parallel servers and infinite queueing capacity. He also developed formulas for queues having finite, even zero, queue capacity. The results were expressible in equation form only for the case of steady state operation, no transients.

The motivation of Erlang's historic assignment persists to this day in virtually all service industries: management examining the tradeoffs between service capacity, with its costs of capital and workers, and system performance, with its more indirect costs related to customer satisfaction and resulting market share. As capacity increases (decreases), performance improves (degrades). Since Erlang's time, we estimate that up to 10,000 scientific queue papers have been published, and more than a handful of books. Despite this largess, there are still myriad queues that require description and analysis. Some do not even appear to be queues. We visit some in this chapter.

## 15.2 Hypercube Queueing Model

When one calls an emergency number—such as 911 in the United States or 119 in Japan—to report the need for on-scene assistance from police, fire, or ambulance services, one enters a complex multi-server queue. It's often a "life-or-death queue," as speed of response can determine whether the people experiencing the emergency live or die. After the caller has relayed the required information to a phone operator

(a more-or-less standard Erlang-type queue), the information is quickly forwarded to a dispatcher, who assigns the call to one of $N$ "servers" in the city or region, the servers being police cars, ambulances, or fire trucks. The dispatcher is the operational "server manager."

The servers of this queueing system are spatially distributed, and each server faces its own local pattern of requests for service. Here, we consider the simple case in which only one server is dispatched, most appropriate for ambulances and police cars. The dispatcher must select the best available server to assign to the call. To complicate matters, when the server whose home location is closest to a call is already busy on a previous call, the dispatcher assigns a nearby available server—in order to minimize response time. So, there is a complex inter-zone cross-dispatching process that must be modeled to create accuracy for planning purposes. This heterogeneity of the server pool is what distinguishes the Hypercube Queueing Model from the Erlang *M/M/N* model. With the Erlang model, the state space of the queueing system is the set of non-negative integers, where state $i$ represents $i$ customers in the system, $i = 0, 1, 2, \ldots$. All of its servers are in essence statistically identical "clones." With the Hypercube model, knowing that 5 of $N = 10$ total servers are currently busy is not sufficient for us to evaluate system performance. So, one possible state having five servers busy in a 10-server system is the 10-digit binary number 1000110101. Here a "1" in the $j$th digit implies that server $j$ is busy, whereas a "0" means server $j$ is not busy and is available for dispatch assignment. Of course, there are many other states having five "1's" in the 10-digit binary number. Because of the expanded state depiction, the state space for the Hypercube model is an $N$-dimensional unit hypercube, the reason for the model's name.

This model was brought to completion and published in 1974, complete with the computer codes of the day (Larson 1974) As of 2018, about 45 years later, the Hypercube model has been cited more than 650 times and has been implemented for emergency services design and management in many countries.

An original limitation in the model's use was the value of $N$, the number of spatially distributed cooperating servers. A value of $N = 10$ implies a state space of $2^{10} = 1024$ states, requiring solutions to that many simultaneous linear balance-of-flow equations. The computers of the 1970s were quite limited, basically 23 generations of Moore's Law from where we are today (2018). On MIT standard computers of the day, we were able to solve the Hypercube model for up to $N = 12$ servers, implying $= 2^{12} = 4096$ states. We were hopeful that $N = 12$ would be sufficient for most applications. But we soon received a call from the New Haven Connecticut Police Department. They wanted to use the model, and reported a spatially distributed fleet of 42 police cars. I asked them, "*OK, these must be assigned to precincts or divisions, each of which acts independently from the other. So, how many are deployed to each precinct?*" Answer: "*42, only one precinct in New Haven. Any police car can be dispatched to any address in the city.*" Our hearts sank, as $2^{42} = 4{,}398{,}046{,}511{,}104$ states was far beyond any widely accessible computer's ability. Soon, the first Cray supercomputer was announced (1975). These large, heat-generating supercomputers were the talk of university campuses, requiring significant queue delays to use them. But we also realized that cities and towns

that wanted to use the Hypercube model would likely not have access to a Cray supercomputer. Nor were we even sure that a Cray could solve the Hypercube for $2^{42}$ = states. (Depending on how you calculate it, a typical pocket-sized smart phone today is equivalent to three or more Cray supercomputers!)

Because of New Haven and other cities like it having large values of *N*, we quickly focused on finding a much less computationally demanding way for computing the key performance measures of the Hypercube model. These measures were primarily response times to the various neighborhoods and workloads (i.e., fractions of time busy) of the servers. We arrived at a procedure that in effect samples servers without replacement, deriving a set of equations whose solutions closely approximate the solutions to the exact Hypercube model. The new method requires the solution to only *N* simultaneous nonlinear equations, in contrast to $2^N$ simultaneous linear equations for the exact Hypercube model. The process of successive substitutions usually leads to convergence in about three or four iterations. For 2 years, we ran the two methods—exact and approximate—side by side, and never did we see the approximate model deviate by more than 2% from the exact model. This approximate procedure was published, again with computer code, in 1975 (Larson 1975) This paper has been cited 385 times, and is most likely the preferred method for coding the Hypercube model.

A very accessible technical description of the Hypercube Queueing Model, along with its approximation procedure, is found in the free online version of the textbook *Urban Operations Research*. http://web.mit.edu/urban_or_book/www/book/chapter5/contents5.html (Larson and Odoni 1981). Reflecting on this 45-year history, one sees how advances in computers can help advance applications of operations research, in this instance a queueing model having an exponentially large state space. This interplay between computers and operations research is why the senior author here decided to submit the original Hypercube paper to the inaugural issue of a new and unknown journal, by definition having zero impact factor, namely *Computers and Operations Research*. Today the 5-year impact factor of this respected journal is 2.83. The senior author thanks the late Dr. Samuel J. Raff (1921–2011), the founding editor of the journal, for quickly and enthusiastically accepting the paper (INFORMS News 2011).

Thanks to Moore's Law, many even more complex queueing systems are controlled today—in real time. A classic example is networks of intelligent traffic lights covering regions of a city or municipality. Such systems can drastically reduce the queue delays experienced in cars, often the largest single contributor to queue delays in typical American lives. Even more promising, but more daunting from an algorithmic perspective, is the notion of platoons of driverless cars and trucks traveling in close proximity synchronously on interstate highways. With these real-time queue control technologies, the capacities of these highways should be significantly increased—without adding more concrete or asphalt.

## 15.3 Multi-Year Queues in the Labor Force

While minutes and even seconds are important with emergency response services, some queues operate on a time scale of years. Consider universities that perform research and education, two vital services for the US economy. While university campuses have many traditional stand-in-line queueing systems, the labor components of a university move at a much slower time scale.

### *15.3.1 Postdocs*

Consider the population of postdoctoral fellows ("postdocs") who spend 1, 2, or even up to 10 years in the temporary position of postdoc, hoping to land a tenure-track assistant professorship. Postdocs comprise an increasingly large fraction of the research staff at universities. For example, MIT's School of Engineering (SOE), where postdocs were rare 25 years ago, now has 1.4 postdocs per SOE faculty member. Postdocs primarily perform research, often building from their Ph.D. theses, leading to publications that will strengthen their résumés, thus making them more competitive on the academic job market.

We may view this population as a "labor force in waiting," in queue. This is not one physical queue where all postdocs are standing in line; rather, it is a spatially dispersed queue of individuals, each located at a university or research lab. Here, the "service" provided when the postdoc leaves the queue is the awarding of an assistant professorship. However, the input rate lambda ($\lambda$) to the queue, the mean number of new postdocs entering each year, exceeds the number of assistant professorships available. So, we have a saturated queueing system where the service requested exceeds system capacity. To reach a steady state, there must be reneging from the queue, the act of leaving postdoc status without having obtained the desired service—the coveted assistant professorship.

In a recent paper (Andalib et al. 2018), we used standard methods of queueing theory to model multi-year postdoc queues. One can see the sharp growth in the numbers of postdocs in Fig. 15.1.

The parameters of our model parallel those of more traditional queueing systems:

- *Queue inflow rate* ($\lambda$)*:* The annual arrival rate of new Ph.D.s who take postdoc positions in the postdoc queue.
- *Time-average number of postdocs in the queue* ($L$)*:* This is the average population of postdocs in the queue.
- *Queue service rate* ($\mu$)*:* The service rate ($\mu$) is the average annual number of tenure-track positions taken by postdocs.
- *Reneging rate* ($\gamma$)*:* Individuals who leave postdoc positions to industry or to non-tenure track positions renege from the queue before being served. The parameter $\gamma$ is the reneging rate per person. Here, $\gamma \Delta t$ is the probability that any

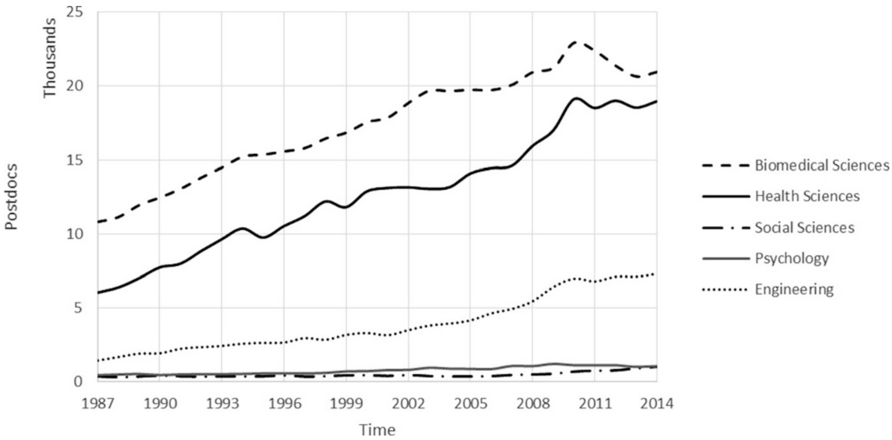



**Fig. 15.1** Number of postdocs in the United States by major field 1987–2014. (Survey of Doctorate Recipients. (2013). National Center for Engineering Statistics & National Institutes of Health)

given postdoc reneges in the next infinitesimal period of time duration of $\Delta t$. Over 1 year, the average number of postdocs who renege from the queue is $L\gamma$.

- *Average waiting time (W):* This is the mean duration of a postdoc career, equivalent to the mean time spent in the postdoc queue.

Our queueing model is straightforward. Since the service rate *m* is less than the arrival rate *l*, only a fraction of postdocs will become assistant professors, that is,

$$P\{\text{becoming assistant professor}\} = \frac{\mu}{\lambda} \tag{15.1}$$

Similarly, all others will renege from the queue,

$$P\{\text{renege}\} = 1 - P\{\text{becoming assistant professor}\} = 1 - \frac{\mu}{\lambda} \tag{15.2}$$

Finally, we have conservation of mass: Total system inflow must equal total system outflow, the outflow being from both "service" and reneging,

$$\lambda = \mu + L\gamma \tag{15.3}$$

We can now invoke Little's Law of queueing (Little 1961) to estimate *W*, the mean time spent as a postdoc. Little's Law is stated as

$$L = \lambda W, \tag{15.4}$$

where *L* is the time-average number of postdocs in the system (assumed to be operating in steady state), $\lambda$ is the annual number of new postdocs per year, and *W* is

the mean time (in years) spent as a postdoc. Using the above results, we can now write,

$$W = \frac{L}{\lambda} = \frac{(\lambda - \mu)/\gamma}{\lambda} = \frac{\lambda - \mu}{\lambda\gamma} \tag{15.5}$$

In the aforementioned paper, we use data from the Survey of Doctoral Recipients (SDR), conducted by the US National Science Foundation (NSF). We consider the fields of biomedical sciences, health sciences, social sciences, psychology, and engineering. We find that, averaged across all fields, 83% of postdocs will renege from the postdoc queue, that is, will not successfully land a tenure-track assistant professorship. The highest rate of reneging is in engineering with 84%, and the lowest is in social sciences with 72%. The estimated mean time as postdoc is 2.9 years across all fields, with biomedical sciences having the largest mean time as postdoc at 3.6 years. Our queue modeling results are consistent with those reported by others who used entirely different modes of analysis.

### *15.3.2 Faculty Careers*

There are university-based queues where $W$ is even much longer than 3 or 4 years. And that is the queue of tenure-track faculty members. You may ask, what is the queue in this instance? Imagine the 1000 or so tenure-track MIT faculty members. This queue has been in steady state for almost 35 years, with no trends up or down in $L$ = time-average number of faculty in the system. Typically, as discussed in the previous section, new faculty members enter the tenure-track status as assistant professors, more and more these days directly from a postdoc position. They remain "in this queue" as long as they are tenure-track faculty members. What is "service" in this queue? It is retirement from the faculty at MIT becoming either "Professor, post-tenure" or "Emeritus/Emerita Professor." Is there reneging from this queue? Yes, some leave due to lack of promotion or failure to obtain tenure within about 7 years. Others leave voluntarily often to assume high-level positions—such as presidents—at other universities or in industry. Leaving due to death is very rare, less than 1%.

You may ask, "Why would we look at the set of tenure-track faculty members as a queue? What is the need for this?" A key observation is this: As soon as one finds a stochastic system whose population is in steady state, one can directly apply Little's Law of queueing to infer certain performance measures of the system. In the year 2011, for example, grant managers at the NIH, as part of our multi-year research grant, asked us to investigate this issue: How have changes in federal mandatory retirement ages affected the number of new assistant professorships at research universities? The National Institutes of Health (NIH) is the world's largest supporter of research, and leading people at the NIH were quite concerned that a smaller and smaller fraction of their recently minted Ph.D.s were successfully obtaining

tenure-track faculty positions. When this problem was announced, we very quickly saw that the issue could be viewed as a queueing problem.

When I (coauthor Larson) was hired as assistant professor at MIT in 1969, I was told, "*Dick, when you reach age 65, you must retire! It's the law.*" Being 26 years old at the time, that seemed like the infinite future for me, so retiring at 65 was a non-issue. This mandatory retirement rule came from the Federal Age Discrimination in Employment Act of 1967 (Pub. L. 90-202) (ADEA). Over the years since 1967, this law was amended from time to time. Faculty mandatory retirement at age 65 remained in place until 1982. Then, due to amendments to the ADEA, the minimum allowable mandatory retirement age was increased to age 70. In 1986, Congress made additional amendments to the ADEA, prohibiting any mandatory retirement ages for most workers in the United States. Eventually, this was applied to university faculty members, whose mandatory retirement age now is infinity!

Getting back to the NIH question, the focus is now narrowed: "*How have the changes in mandatory retirement ages affected the flow of available new assistant professor slots on university campuses?*" Without a queueing framework, one might be tempted to argue the following: "The change in mandatory retirement age from 65 to 70 in 1982 would cause a transient blip downward in new assistant professorships, since those nearing 65 who had intended to retire will now wait until they are 70. But this transient blip will be short lived, and after 5 or so years, the former equilibrium will be re-established, having no effect on new assistant professorships." A similar statement arguing a transient blip might be made for the second change, when faculty members were no longer required to retire at age 70 but rather later, whenever they chose to retire. There is one word for such logic: WRONG!

In a 2012 paper, MIT Masters student Mauricio Gomez Diaz and I analyzed the problem from a queueing point of view (Larson and Diaz 2012). In application to university faculties, the quantities of Little's Law are defined as follows:

$L \equiv$ the time-average number of tenure-track faculty members employed by the university;

$\lambda \equiv$ average annual rate at which new tenure-track faculty members join the faculty; and

$W \equiv$ the average number of years spent on the faculty by a newly hired assistant professor.

Here, we have a most unusual situation. $L$ is a known quantity, equal to 1000 tenure-track faculty members at MIT for the past 35 years! The system is indeed in steady state. Using promotion and retirement data, we can accurately estimate $W$, the average number of years spent on the faculty by a typical new assistant professor. Then we would be applying Little's Law to a situation in which the unknown is $\lambda$, the annual inflow of new assistant professorships. In almost all applications of Little's Law in the literature, the in-flow parameter $\lambda$ is a known quantity, and we would be solving for either $W$ or $L$. In this case, we solve for $\lambda$.

To estimate $W$, we think of the key decision points made for and by this faculty member as she or he proceeds through her or his career. A typical career trajectory involves the following five milestones:

1. At end of Year 2, reappointment as assistant professor without tenure.
2. At end of Year 4, appointment as associate professor without tenure (AWOT).
3. At end of Year 7, appointment as associate professor with tenure.
4. Remaining on the faculty until retirement, not voluntarily departing from the university at some pre-retirement time, most often associated with a faculty or business appointment elsewhere.
5. Retirement from the faculty.

Milestone 4 is not really a specific time-marked event. It is included to account for those faculty, typically in their 40s or 50s, who voluntarily leave to become deans, provosts, and presidents at other universities or to engage full time in some business or government activity.

The aforementioned paper describes how we obtained reliable estimates for all required parameters for the queue model, including conditional probabilities for reaching each of the five steps above. To compare the two extreme policies, retirement at age 65 vs. no mandatory retirement age, we needed to find an estimate for the average age at which the typical MIT faculty member would retire—under the current rule of no mandatory retirement age. MIT reported to us that their experience pointed to age 74 or 75 as the mean age of then-current retirements. So, we used 75. Our calculations indicate that, with a mandatory retirement age of 65, and given the assumptions regarding milestone probabilities, the average career time spent on the faculty by a randomly chosen, newly hired 30-year-old assistant professor is 17.64 years. Plugging this into Little's Law, we find $\lambda = L/W = 1000/17.64 \approx 57$ new assistant professor faculty hires per year. Now, switching to a mean retirement age of 75 (assuming promotions, tenure, and other steps that get one to this age), average career time spent on faculty increases to 21.56 years. Plugging this into Little's Law gets us $\lambda = L/W = 1000/21.56 \approx 46$ new assistant professor faculty hires per year, a reduction of about 19% compared to the retire-at-65 policy with 57 new hires per year. That is, about 11 would-be new appointments, over all of MIT, would not be made due to the increase in retirement age.

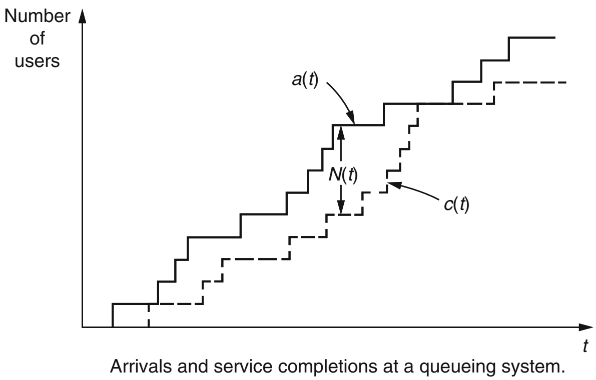
Ours is a steady state result, indicating that outcomes far beyond transient effects are at play here. The people at NIH were shocked at the first-order magnitude of this system effect. Our belief is that if the parameter values were updated to current conditions, the effect would be even larger, that is, even fewer new assistant professorships each year. The reason is that those who are hired now, typically from an applicant pool of 400 or more, tend to be very strong academically in their fields, much more so than their predecessors. Thus, their chances for promotion and tenure would tend to be greater than those of even 10 or so years ago. Perhaps the reader would like to do this exercise for his or her own university. As a final note: Prof. John D. C. Little, author of Little's Law, reported to us that the above analysis is the most unusual application of Little's Law that he has ever seen!

## 15.4 Homeowner Queues—Downed Power Lines

If you own a home, there are myriad queues that you may experience. Most pertain to services. They can range from the small—waiting for delivery of an expected package, to the medium—waiting for a remodeling project to be completed, to the large—waiting to sell your house. But, living in the northeastern United States during the winter of 2017–2018, with four serious Nor'easters in about one month's time, most of us were made aware of a very inconvenient and possibly dangerous queue—waiting for electric power to be restored after falling trees or tree limbs knocked out neighborhood power lines. Some New England homeowners waited many days for the lights to come back on. In addition to the inconvenience of no electricity, there was frustration coming from the seemingly random restoral of power—some towns and neighborhoods were restored quickly and others days later. To the typical homeowner, the "queue discipline," that is, the order in which homes are selected for restoral, may appear random and perhaps even unfair. Since there is no distinct queue line with place in queue indicating time of power outage, no one can tell if first-come, first-served is heeded. In fact, queueing theory suggests that first-come, first-served would be a bad strategy for the electric utility. Why?

In Fig. 15.2 we depict the cumulative number of arrivals $a(t)$ and the cumulative number of departures $d(t)$ from a queueing system over the course of one busy period, that is, a period during which the server is continuously busy. The difference $[a(t) - d(t)]$ represents the total number of customers in the system at time $t$. The area between the two curves over the course of the busy period represents the total customer minutes spent in the system, both waiting in queue and being served. If $N$ is the total number of customers served during the busy period, then the average time spent in the system by a random customer in the busy period is equal to the area between the two curves divided by $N$. Thus, for any busy period of any queue, we see that this area between the cumulative arrival curve and the cumulative departure curve is critical in determining time spent in the system by customers. Reducing the area reduces time spent in the system, implying reduced time in queue.

**Fig. 15.2** Illustration of a Queue's Evolution, Leading to Little's Law



How does one reduce the area between the two curves? Clearly, one cannot influence the arrival times of customers, as that is their choice (or in the case of downed electrical power lines, nature's choice). But what about the departure process? Can we influence the shape of $\underline{d(t)}$? Yes, we can select a queue discipline that pushes $\underline{d(t)}$ upward to the left, closer to $a(t)$. That would reduce the area between the two curves and thus reduce the average in-queue waiting time of customers. With a workload conserving queue discipline, in which each customer has its own service time—regardless of delay until service commencement, we leave it to the reader to verify that the total duration of the busy period is not influenced by queue discipline. Assuming a single server queue, the total time of the busy period is equal to the sum of the individual service times, regardless of the order of service! It's that simple. What queue discipline should we apply? We leave it to the reader to verify that three popular queue disciplines—first-come, first-served; last-come, first-served; and service in random order, would not change—on average, the areas between the two curves.

We need something else. Suppose at the instant that a customer leaves and a new customer is to enter service, there are two queued customers to select from, Tom with service time 10 units and Sally with 1 unit. By next selecting Sally, the customer with shorter service time, you remove at least 9 min of wait time from the system, the extra 9 min that Sally would have to endure while Tom was being served. In general, moving to a Shortest Job First (SJF) queue discipline pushes the departure curve $d(t)$ upward as fast as possible, minimizing the mean queue delay over the population of customers. Longest Job First (LJF) does just the opposite—it maximizes mean queue delay over the population of customers. Many of us utilize an SJF queue discipline in our daily lives, operating our email in-box! Quick and easy emails are handled first, often with a simple "Yes" or "No" or trashing. More complicated longer emails often languish, sometimes for days or even weeks.

How does all of this pertain to electric utilities repairing downed power lines? Consider two downed power lines, one serving three homes and the other 30 homes. On average, the time to repair each downed line would be the same, regardless of the number of customers affected by the breakage. Fixing first the second line, the one serving 30 homes, gets 30 homes back on electricity more quickly. Fixing the other line first, the one serving three homes, causes all 30 other homes to wait in queue during the three-home repair process. So, a repair queue strategy of fixing first those downed power lines serving the greatest number of customers is a form of SJF queue discipline. One can see this by apportioning 1/30 of the repair time to each of the 30 affected homes. With the other option, one can only apportion 1/3 of the repair time to the three affected homes. Here, clearly 1/30 of the repair time is much less than 1/3 of the repair time, as the strategy follows a SJF queue discipline.

We researched the manner in which power was restored in New England during the Nor'easters and discovered links between theory and practice. Eversource Energy, the largest energy provider in the New England area (Massachusetts, Connecticut, New Hampshire), provides energy for over 1.7 million customers throughout Massachusetts alone. Because of back-to-back Nor'easters in March of 2018, Eversource had been dealing non-stop with downed power lines and debris,

such as fallen trees, taking out electricity. This resulted in crews that worked overtime and the recruitment of out-of-state crews for help with restoring power in the area. In some towns, town officials publicly expressed anger and frustration at Eversource's response. Marion's Selectman, Norm Hills, stated, "*There has to be some fundamental problem if we can lose 100 percent power twice.*"

William Zamparelli, Eversource's community relations representative, walked us through the way Eversource assigns priority and thus resources to repairs. Because of their relationship with the Massachusetts Department of Public Utilities, Eversource is required to work the largest block of customers first, regardless of distance or geographical constraints. In most cases, this also happens to be the aforementioned optimal "Shortest-Job-First" queue discipline. However, with that said, before Eversource sends in crews to do these "optimally sequenced" repairs, police and fire (and other first responder facilities) are repaired first; additionally, Eversource contacts all life support customers before a storm hits to help them prepare for impending outages. Queues and electricity outages, who would have thought of it?

## 15.5 Queues for Human Organ Transplants

Imagine that you are very ill; one kidney has already been removed and the remaining one is not functioning properly. *You are in a queue, a life-and-death queue. You need a new kidney!*

It may be difficult to think of the process of human organ transplants as a queue. Many Americans have experienced this process in some way, whether being asked to sign up as an organ donor, or navigating the complex undertaking of getting on the organ transplant waiting list, for themselves, family members, or friends. Certainly not a queue as in Disneyworld or Dunkin' Donuts or the Department of Motor Vehicles (DMV), but the organ transplant process is very much a queue. Accordingly, we can apply queueing theory to address system performance just as we would with any other queue.

*Getting on the List.* Getting put on an organ transplant waiting list, or queue, is an involved and often lengthy process. Prospective organ recipients likely experience as much anxiety attempting to join this queue as they do waiting in it. There is a severe organ shortage in the United States. The demand for organs by patients far outpaces the availability of organ donations, especially for kidneys. The primary governing body for this process, the United Network for Organ Sharing (UNOS), instructs prospective recipients, after discussing options at length with their primary healthcare providers (U.S. Department of Health & Human Services (n.d.-a)).

*Nuances and Constraints of the Organ Transplant Waiting List.* In the United States, organ queues are structured by geography in 11 different regions. There is a significant difference between the number of organs donated by southern regions and northern regions, with the former numbering nearly 2000 more organs (U.S. Department of Health & Human Services (n.d.-b)). Regional mean wait times vary

by a factor of six, from 1 to 6 years. The 11 regions are further divided into 62 local areas, with each one represented by one organ procurement organization, or OPO. When an organ becomes available in an area, that area's OPO communicates with UNOS to find an "appropriate" match.

Transplant centers may reject not only a patient, but also organs offered on behalf of patients. Consider livers: While there are approximately 17,000 prospective liver transplant patients in queue at any given time, only about 6000 of them ultimately undergo a transplant during a year, while roughly 1500 die each year waiting (Yasinski 2006). Clearly, there is a severe shortage of livers available for transplant patients; however, in spite of this, livers are rejected by transplant centers for myriad reasons.

When a liver becomes available, as with any other organ, the donor's information (weight, blood type, geographical location) is entered into the system by UNOS, which then suggests prospective patient matches for the liver. From there, the patients are ranked on a supposedly objective measure of illness known as a Model End-Stage Liver Disease score; under this measuring system, the patient most likely to die first gets priority on the organ. This mechanism is designed with the intention of balancing equity with maximizing patient odds by selecting from patients most likely to have positive outcomes.

One transplant center's study revealed that for 27,000 liver donations, only 37% of these donations were accepted by transplant centers. The exact percentage of offers accepted varied across transplant centers from 16–53%. In many cases, organs rejected by transplant centers go unused because of time and geographical constraints, around 10% for livers, which considering the severe organ shortage, is not insignificant.

*Organ Transplants and the Black Market.* The organ market in Bangladesh provides an illuminating example of illegal trafficking in human organs. False advertising on the part of organ traders exacerbates this exploitation of low-income Bangladeshis. These advertisements range from extreme sympathy stories featuring prospective organ recipients in dire need of a kidney to false promises of foreign citizenship to claiming that one's second kidney is only "sleeping." Of note, in a field study of 33 Bangladeshi organ sellers interviewed, all but one were Muslim. However, Islam has a strong stance against body mutilation, and for many of these men, remorse carried religious undertones following their organ-harvesting surgeries. Additionally, following surgery, the economic status worsened for many of these individuals losing a kidney, as they were physically handicapped and unable to return to work.

It is believed that illicit organ trafficking networks like the one uncovered in Bangladesh exist in many nations. In fact, it is estimated that 5–10% of all kidney transplant operations worldwide are done with trafficked organs (Resnick 2012).

*What are the alternatives?* A number of solutions are being offered for organ shortages, but many carry heavy moral dimensions. The Bangladeshi situation demonstrates that an unregulated organ market has negative implications for cash-strapped individuals while benefiting the few. Alternatives to traditional organ markets have been suggested. Economist Alvin Roth advocates for compensating

individuals for donating their organs by covering medical costs for the procedure, which he believes will mitigate the financial factors that make people hesitant to donate. For another incentive, individuals in Israel registered as organ donors have priority when it comes to receiving organs, an interesting way to both arrange the queue and increase the potential supply.

Iran provides an interesting case study on "paid" organ donations. Currently, Iran is the only country with a regulated organ market. In the 1990s, Iran started paying for the medical costs of kidney donors, and in doing so avoided the cost of treating ill individuals for their kidney-related diseases. The program was successful in eliminating Iran's national waiting list for kidney transplants, as well as the Iranian organ black market.

From our point of view, the alternative having the highest potential and least complication deals with ***opt-in versus opt-out organ donation schemes***. In the United States, one has to opt in to become an organ donor. In Spain, everyone is automatically an organ donor, unless one opts out. Spain stands out, as the implementation of its opt-out model is leading its success. Despite crippling governmental austerity, Spanish healthcare providers conducted over 4000 organ transplants in 2016 (Govan 2017). In comparison to other EU states like Norway and Turkey, which maintained organ waiting lists of over 86,000, Spain's waiting list hovers slightly above 5000. Even considering Spain's overwhelming success with its opt-out system, there is no definitive proof that such a system would work everywhere, as other factors such as the strength of a nation's medical infrastructure also play an important role. In general, however, nations with opt-out systems have a greater number of total organs transplanted, when measured on a per-capita basis.

The current US organ donation rate per million population is 26, compared to Spain's 35.3—nearly a 10 point difference. Imagine if the United States were to adopt a new policy that increased its organ donation rate by 10 points, possibly an opt-out system or perhaps something akin to Israel's priority policy or even Iran's compensation model. Suppose the United States had made these changes successfully 25 years ago, the same time Spain started shifting its approach to organ donation. Of 10,000 extra donations per year, say only 50% of them became successful transplants—even so, that's an extra 125,000 lives that could have been saved or enriched over the past 25 years. Our point is that all donors carry the potential to save lives, to "serve" fellow citizens in their country's life-and-death human organ queue.

## 15.6 Cross-Cultural Differences in Queues

People's behavior in a queue represents a microcosm of the broader society in which they live. Depending on a person's culture, queueing behavior and norms can differ significantly. For example, different cultures have different definitions of personal space, which can influence the physical length of a queue depending on how much space is allotted in between each adjacent queuer. Studies have found that "the

farther to the south and east you go, the shorter the interpersonal distance, and the higher to the north, the more [personal space] between strangers" (Høgh-Olesen 2008). This suggests that people from Greenland, Denmark, and Finland keep significantly larger interpersonal distances than people from India and Cameroon.

Cross-cultural examination of proxemics can provide enlightening information that explains the differences in queuing behavior from around the world. A New Yorker living in Taiwan, a place that would be categorized as having less personal space, reflected upon her experience in interacting with Asian tourists in queues:

> "*I was standing in line at a post office sorting through some things, when some tourists came up behind me and told the agent that they needed to exchange money. Even though the agent was clearly helping me, the tourists still made sure that their request was acknowledged first. Even when you tell them that there's a queue, they somehow always manage to stand uncomfortably close to you in a way that seems like they're about to rush to the counter whenever there's an opening*" (Interview with Cordelia Zhong 2018).

Because cultures have different definitions of comfort in regard to personal space, it can affect people's overall view of the queue.

Another culturally dependent aspect of queues is the level of impatience of the people in queues. Depending on the culture, the perceived value of receiving something immediately can vary. Research shows that Westerners value immediate consumption relatively more than Easterners. Findings also show that Easterners are more impatient when faced with the possibility of a substantial delay in receiving a product (a *prevention loss scenario*), whereas Westerners are more impatient when they are threatened with not being able to enjoy a product essentially "now" (a *promotion loss scenario*) (Chen et al. 2005). The range in consumer impatience can have phenomenological consequences for people in queues, as the diversity of cultures within a queue can cause differences in degrees of satisfaction.

*Celebratory Queues*. As much as people dislike queueing, they also form what are known as celebratory queues. Humans will willingly line up or camp out for things, and will view the experience in a positive manner after they have received whatever service or good for which they camped out. They view the process as being a part of a community, allowing for social interaction with some temporary neighbors, as well as bragging rights about being the first to receive whatever product or service for which they were in queue. One well-known example: the queues that form whenever a new generation of the iPhone is to be released. Through these celebratory queues in anticipation of the new iPhone, queuers can find a sense of community with other people who share the same excitement for the iPhone; and it gives them bragging rights.

One of our favorite celebratory queues is the "tenting" tradition at Duke University to gain entry into the annual men's basketball game of Duke University versus University of North Carolina (UNC)—Chapel Hill. Beginning in the late 1980s, the tradition of camping out several nights before the Duke vs. UNC game would eventually become a grandiose process with its own 40-page rulebook and a name for the place where all the student tents are pitched. Hundreds of students will camp

out in tents in Krzyzewskiville (“K-ville”), around six weeks before game day, to secure entry and the best seats to the game starting in January or February. Strict rules surround the tents and life in K-ville, and line monitors ensure that they are being followed thoroughly through tent checks at random times of day and night. For example, a certain number of people need to be inside the tent at all times, and line monitors will conduct checks at random times of the day, even the middle of the night, to see if there is indeed the necessary number of people inside. If you fail two checks, then your entire tent will be removed and unable to gain access into the game.

Many undergraduate students view the tenting tradition as an important part of their Duke experience, with some aspiring to make it into the game in all 4 years. Recently, the tradition has grown in popularity, to the point that a preliminary trivia test had to be conducted to select a set amount of student tenting groups to be part of the tenting process in 2017. This tenting tradition at Duke University is one extreme example of a celebratory queue, but the idea of being part of a community and sharing an experience that culminates in bragging rights about a highly sought-after product or service is exemplified. Not all queues are bad; some offer life-memorable positive experiences!

## 15.7 Human Behavior in Queues

*Queueing: Perception vs. Reality.* Imagine you are rushing to the airport to catch your plane. You run until you get to the security control and realize there is a line of ten people ahead of you waiting to be screened. Everything seems to be moving slower than usual and seconds seem like minutes. When you finally get your turn, you feel as though you have been waiting for a long time when in reality it might have been only a couple of minutes.

In a study which examined customer perceptions of waiting in line (Katz et al. 1991), it has been found that in a given setting, customers, on average, overestimated waiting time by 1 min, and that waits of 5 min or less were considered reasonable. When it comes to customer satisfaction, what truly matters is how the customer feels about the wait as opposed to how the wait really is.

Maister (1985) investigated the psychology of waiting lines and gave eight propositions:

1. Unoccupied time feels longer than occupied time.
2. Pre-process waits feel longer than in process waits.
3. Anxiety makes waits feel longer.
4. Uncertain waits seem longer than known, finite waits.
5. Unexplained waits seem longer than explained waits.
6. Unfair waits seem longer than equitable waits.
7. The more valuable the service, the longer people will wait.
8. Solo waiting feels longer than group waiting.

These propositions have helped business executives in various industries to significantly increase customer satisfaction and lower costs.

*Queue Rage.* The basic fairness principle that governs most routine queues is the First-In-First-Out (FIFO). When FIFO is violated, queuers might experience queue rage. According to one study (Milgram et al. 1986), a person cutting in line faced objections 54% of the time. With two people cutting in line together, there is objection in 91.3% of the cases. But what happens when a group of people tries to cut in line? Arjun M. shares his story:

> "*A pretty common way to minimize wait time in my home country, Trinidad, was to break up the party in equal groups and send them to different lines and then join the sub-party that ended up meeting the server first. This was especially seen at movie theaters, when groups of teenagers would split up and enter different lines and whichever group met the server first, the rest would simply join. What's worse is that they would pay separately. It was as if 10 new individuals suddenly joined your line. This would frustrate everyone who was waiting in this line whereas the people in the other lines were happy moving up a few places quicker. When this happens, it is very rare for there to be more than shouting; fighting or physical confrontation is definitely not a norm in these situations*."

Reactions of people confronted with queue-jumpers are often shaped by cultural factors, as depicted by the story above. In some densely populated countries, such as China and India, queue jumping is ubiquitous as it is often the only way people can get access to some constrained resources. However, the same behavior in the United States would draw immense disapproval, sometimes even resulting in violent and occasionally deadly altercations.

Road rage is a special type of queue rage that occurs when drivers engage in aggressive behavior such as speeding, line cutting, or driving on the wrong side of the road, all of which can result in road accidents. Ross suggested (as cited in Galovski and Blanchard 2004), that the problem of traffic accidents be addressed not so much through mechanical improvements (car and highway safety features) or education, but through socio-psychological intervention (Ross 1940). The term *Intermittent Explosive Disorder* has been used to describe a behavioral disorder characterized by explosive outbursts and violence, often to the point of rage, that are disproportionate to the situation at hand. However, studies show that social and interpersonal variables contribute to aggressive driving. According to Galovski and Blanchard (2004): "Perceived social class (status), gender, ethnicity, perception of aggression, and age have been seen to play a significant and often overlooked role in the development, maintenance, and exacerbation of aggressive driving behaviors."

*Cue (Queue) the Stampede.* In some cases, queues can become a large crowd without any particular order; in other cases, queues never form. A stampede occurs when a crowd of people collectively runs as an act of mass impulse, often in an attempt to escape a perceived threat. On the other hand, crowd crush happens when people are jammed together so tightly that they can no longer inflate their lungs, and they gradually die of asphyxiation or suffocation.

All of these can be thought of as extreme examples of an absence of efficient queues, where the behavior of the crowd is out of control. Crowd crushes and

stampedes mostly occur during religious pilgrimages, sports events, or wherever there is a large dense crowd without proper regulation. Careful planning and rapid emergency response are crucial in these situations to prevent fatal consequences.

## 15.8 Smart Phone Apps for Managing and Skipping Queues

Queues and smart phones have one thing in common—they're everywhere. In an age of rapidly advancing technology, and a world where humans wait in lines on average 2 years or 2.5% of their lives, many smart phone and tablet apps have been developed to combat queue waits (Rushin 2007). Queueing apps are present in virtually every industry and market, and often seamlessly interface with our day-to-day lives without us even being aware of their influence.

Here's a scenario: Imagine waking up to a late alarm, on an empty stomach, no time to wait for the subway, and knowing that you no longer have time to pick up concert tickets that you *promised* your friends. Perhaps worst of all, time is of the essence and work is on the horizon with a slew of customers waiting for your attention. What do you do? How can you eat, get to work, manage your customers, and get the tickets? Queueing apps provide the solution!

The first order of business is obtaining transportation to work. With the innovation of ridesharing (and queue eliminating) apps like Uber and Lyft, you simply enter your destination on your phone, and a car is on its way to you. In the meantime, your stomach is growling and you need breakfast. Probably the most widely known food queueing app used by the general public is Starbucks' Mobile Order and Pay. This app allows anyone with a Starbucks account to order his or her customized drink in advance and pick it up at a specified time. Just as the TSA-PreCheck line at times is ironically longer than the regular TSA line, this feature occasionally results in longer in-store lines as well. However, with 7% of all orders being placed via smart phone and during periods of high demand, Starbucks is now staffing more employees on the mobile orders and even opening a mobile order only store in Seattle (Ryan 2017). You order your coffee and pastry, and pick them up on your way to work via Uber.

At work, your customers are arriving and are signing in on your company's queue management app. QLess (n.d.), founded by MIT graduate Alex Bäcker, markets itself as the world's best queue management system, helping companies improve customer satisfaction and increase operational efficiency. With QLess and other related apps, customers are able remotely to join a virtual queue from a smart phone or an on-site kiosk and obtain real-time updates on their wait status. Not only are the customers more at ease understanding their position in the queue, but also the business itself is able to obtain statistics on arrival time, service duration, return rates, and more. With apps like QLess and its competitors, Qminder, Skiplino, and QueuePad, businesses are simultaneously gaining insights while keeping customers happy from the stresses of queueing.

On your lunch break, you call up a “line angel” to pick up those concert tickets. LineAngel is an app that allows you to pay a flat fee of $18 for a trained line sitter to stand in a line for you. Line sitters are used when waiting at the Department of Motor Vehicles, restaurants, sporting events, and buying concert tickets as in this case. Afterward, you use a food delivery service like Grubhub, Uber Eats, DoorDash, or Postmates to deliver your lunch. These services usually charge a delivery and service fee, typically $5–10. The extra fees “buy” the convenience of not having to travel and wait in line at the restaurant.

Not every bright-eyed app startup that promises shorter wait times will survive. Eric Meyer’s “Haystack” attempted to conquer moving queues of cars with each driver looking for a curbside parking space. Imagine you have been driving through the streets of Boston, searching for “a needle in a haystack,” or simply put, a parking spot. According to Donald Shoup of UCLA, 30% of on-street congestion is due to people driving around searching for on-street parking (Shoup 2007). When a driver was about to leave her parking space, Haystack allowed people to “sell” that space to the highest bidder. But political figures ultimately determined that city-owned and operated parking spaces were not the consumer’s to sell. Haystack became infamous: *Banned in Boston!* Haystack has been removed from app stores on both Apple and Android devices, and is now banned in multiple US cities (Harris 2014). There may be room to pivot and build on the failure that was Haystack. Traffic congestion in cities remains a large problem, and many tech-minded entrepreneurs will likely soon be looking to capture parts of this market.

What attributes of the queue apps have made them successes or failures? Haystack was unable to gain a large enough customer base before regulatory actions were taken against its premise. However, another difference between Haystack and other successful transportation-based apps comes from its disruption to those who were not using the app. Haystack nearly forced every person driving in the city to download the app, in order to have any hope of obtaining a parking space. And Haystack users were found occupying parking spaces for unnecessarily long times, waiting to sell the space to the highest bidder. Ridesharing apps, on the other hand, do not disturb non-users. In fact, there are many people who take taxis, the subway, or drive themselves everywhere. The convenience, though, is there when needed.

The real benefit of such queueing apps, above saving valuable time, is relieving at least some of the negative emotions of waiting in line. The stress, boredom, and sheer uncertainty of standing idly for an unspecified amount of time can instantly change the tone of one’s day. Lines have become an iconic part of American culture, with the Department of Motor Vehicles being the most insulted of all queues. Fortunately, we live in a time where the small burdens of daily life can be eliminated, sometimes requiring a simple fee, and where new technology empires are being created to overcome inconveniences like queues. We expect to see soon an advertisement for a new queue app that may go like this:

**Lose Wait Fast, Results Guaranteed!**
See results in minutes.
No measuring, no monitoring!
You’ll love the new Low-wait You!

## 15.9 The End of Our Line

We hope you have enjoyed our tour of queues, some fun, some life-or-death, and all—in our opinion—interesting. We deliberately avoided extensive mathematical detail in order to convey to a wide readership the richness and diversity of queues. But it is the study of new and unusual queues that urge us onward to develop new mathematical depictions and solutions. For instance, the postdoc queue of NIH-supported young scholars motivated us to develop a new statistical queue inference methodology in a recent paper (Larson 2016).

All five of us welcome readers' feedback, especially pointing to other important and unusual queues that have not been mentioned here. May all your queueing experiences be pleasant and successful ones!

**Acknowledgments** The National Institute of General Medical Sciences and the Office of Behavioral and Social Sciences Research of the National Institutes of Health (NIH) (Grant 2U01GM094141-05) supported some of the work described herein. The grant, "A Model-Based Examination of Behavioral and Social Science Workforce: Improving Health Outcomes," was awarded to the Ohio State University, MIT, and Virginia Tech. The discussion and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institutes of Health, the Ohio State University, MIT, or Virginia Tech. The Undergraduate Research Opportunity Program (UROP) of MIT supported the efforts of the first four coauthors; for that support, we are most grateful.

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**Sanja Simonovikj** is a sophomore at Massachusetts Institute of Technology, majoring in Computer Science and Engineering. She was born and grew up in the beautiful city of Ohrid, Republic of Macedonia. During high school she took part in numerous Math Olympiads which not only shaped her academic interests but allowed her to travel the world. She was formally introduced to the study of queues by her freshman year advisor, Professor Steven C. Graves. Intrigued by this practical topic she joined a small team mentored by Professor Richard C. Larson and dived into investigating the psychology of waiting lines.

**Richard C. Larson** received his BS and PhD degrees in Electrical Engineering from MIT where he is Mitsui Professor (Post-Tenure) in MIT's Institute for Data, Systems and Society. Prof. Larson founded LINC, Learning International Networks Consortium. He is Principal Investigator of BLOSSOMS, Blended Learning Open Source Science or Math Studies http://blossoms.mit.edu, a ten-country collaboration focused on high school STEM education. Prof. Larson, a member of the National Academy of Engineering, is author of over 150 scientific articles, in the fields of operations research as applied to service industries, health care, technology-enabled education, urban service systems, queueing, logistics and workforce planning.

# Chapter 16
# Clarifying the Concept of Smart Service System

**Chiehyeon Lim and Paul P. Maglio**

**Abstract** A new trend of smart service systems is emerging. Technology is applied intensively to alleviate the cognitive and behavioral load of customers and improve the operations of service systems, thereby enhancing value. Despite the significance of smart service systems in this connected and data-rich world, knowledge on this concept remains insufficient. This chapter builds a theoretical background for smart service systems research. Motivated by recent cases of smart service systems, this chapter reviews the definitions and characteristics of smart service systems discussed in existing studies; integrates empirical insights from studies on the design and development of smart service systems; and further explores the nature of smart service systems by analyzing texts from the scientific literature, news articles, and end-user opinions. By integrating all the information, this chapter aims to clarify the concept of smart service system. Using the proposed conceptual framework and related studies as basis, this chapter also categorizes smart service systems into three types according to the portion of customer roles in technology-based value co-creation: smart self-service, smart super service, and smart interactive service systems. Finally, based on the proposed conceptual framework, this chapter discusses future research topics related to the concept of smart service system, such as autonomous service system as a new type of service system that requires a minimum level of human–thing interaction but works mainly based on thing–thing interaction. This chapter would serve as basis for studying and developing smart service systems.

**Keywords** Smart service · Smart system · Smart service system · Definition · Categorization

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_16

## 16.1 Introduction

Service systems in transportation, retail, healthcare, entertainment, hospitality, and other areas are configurations of people, information, organizations, and technologies that operate together for mutual benefit (Maglio et al. 2009). Service systems have become "smarter" over time with the increasing use of technology in the systems (Lim et al. 2016). Smart service systems can be found in homes (Alam et al. 2012) as well as the energy (Strasser et al. 2015), healthcare (Raghupathi and Raghupathi 2014), and transportation sectors (Pelletier et al. 2011), among many others. As the concepts of service system and smartness intertwine, the academia, industry, and government pay significant attention to the concept of smart service system (e.g., Maglio et al. 2015; IBM Smarter Cities Challenge 2016; NSF 2016). This concept is meaningful in developing and using technology, such as the Internet of Things (IoT) and artificial intelligence (AI), because it represents the ultimate application and integration of technology for value creation for people (Ng and Vargo 2016).

Despite the widespread application and research on smart service systems, knowledge on this concept for its development remains inadequate (Maglio et al. 2015; Larson 2016). This chapter aims to contribute to building a theoretical background about the concept and stimulate debate about the sufficiency of existing efforts at academic and practical levels. Establishing common ground for central terms is essential for scientific progress (Boehm and Thomas 2013); thus, development and innovation in smart service systems require a shared vocabulary across multiple fields (Larson 2016). This chapter aims to establish a common ground necessary for integrating perspectives and capabilities to encourage the research and development of smart service systems and contribute to synergy among different research fields and application areas.

Section 16.2 reviews emerging cases of smart service systems in practice from a service science perspective to motivate the readers. Section 16.3 reviews the definitions and characteristics of smart service systems discussed in existing studies to help the readers develop a basic understanding of smart service systems. Section 16.4 reviews studies on the design and development of smart service systems to help the readers understand data-based value creation mechanisms of smart service systems. Section 16.5 introduces the authors' findings from analysis of 5378 scientific articles, 1234 news articles, and 444 user opinions related to smart service systems (e.g., keywords, research topics, and technology factors of smart service system) to help the readers understand the diverse features and core of smart service systems at the same time. Section 16.6 aims to clarify the concept of smart service systems by integrating findings from the previous sections. Section 16.7 integrates the proposed conceptual framework and related studies on service categorization and value co-creation to categorize smart service systems according to the portion of customer roles in technology-based value co-creation. Section 16.8 discusses promising future research topics related to the concept of smart service

system, such as the service systems analytics and engineering and autonomous service system. Section 16.9 concludes this chapter.

## 16.2 Observation on Emerging Cases of Smart Service System

Value may be co-created between customers and firms (Prahalad and Ramaswamy 2002) or between any two actors (Vargo and Lusch 2016). More generally, value is constellated by a network of multiple actors and their interdependent relationships (Normann and Ramirez 1993). Value co-creation and value constellation are powerful concepts in analyzing and designing service systems (Payne et al. 2008; Patrício et al. 2011) because these concepts enhance the degrees of freedom to find fresh and innovative solutions for value creation, aside from existing product or service concepts (Lusch and Nambisan 2015).

This chapter takes a service science—a value co-creation conscious—perspective in viewing this connected and data-rich economy. From this perspective, the essence of the IoT (Atzori et al. 2010) is the enhanced connectivity between stakeholders that may increase encounters for value co-creation or constellation, whereas the term "big data" (George et al. 2015) pertains to the increased types and amounts of traces of the value co-creative activities and interactions within a service system that can be used in understanding and improving the activities and interactions.

Increased connectivity and the proliferation of data produced various forms of service in which stakeholders can monitor, be aware, and manage connected things and other stakeholders better than before. People call such services "smart" may be because of this intellectual property. For example, automobile manufacturers analyze car conditions and driving data collected from connected cars, and they provide various types of useful information to assist drivers on fuel efficiency, safety, consumable, and navigation (Lim et al. 2018a). Smart band-based fitness tracking services collect data from daily life, such as behavior, health, and food menu data, to help people achieve specific fitness-related goals, such as walking 10,000 steps a day (Takacs et al. 2014). Other examples include tire pressure monitoring (Velupillai and Guvenc 2007), vehicle fleet management (Volvo 2009), screen golf training (Jung et al. 2010), and precise farming solutions (Lim et al. 2012).

Apart from commercial examples, smart service systems are emerging in public domains (Lim et al. 2018e). The Seoul government collected data from city buses, identified patterns and demands of city bus usage at midnight, and subsequently improved the midnight bus services for citizens (NIA 2013). Waste management in Delhi collected data from trash bins using radio frequency identification tags and scheduled trash collection locations and time (Purohit and Bothale 2011). Air pollution monitoring in London analyzed data from pollution sources across the city along with European weather forecasts to create a pollution map of London. Precipitation monitoring in Rio de Janeiro used a flood prediction model based on

land survey data, precipitation statistics, and radar data (Kitchin 2014). Transportation management in Singapore collected data from roads and taxis to anticipate future traffic and control traffic lights (Lee 2013).

A common aspect of these cases is the use of sensor data collected from connected things and people. With recent advancements in sensing technologies, various kinds and massive amounts of data are collected from individuals and objects through sensor-equipped consumer electronics and industrial engineering systems (Porter and Heppelmann 2014). Human-generated data involve a hypothesis or bias of recorders, whereas sensor data are natural records that reflect real behaviors of people and operations of objects. One difficulty in managing and improving a service system, which is sometimes conceptual, was a lack of data required to track, measure, model, modify, control, and manage individual behaviors and object operations within the service system in question. The recent advancements in sensing technologies unlock this limitation and provide numerous opportunities for engineering service systems. Thus, the degree of freedom to develop smarter service systems is increasing. From a service science perspective, using sensor data contributes to operationalizing or even automating value co-creation among connected people and things, and this is why smart service systems are meaningful to people (for their value creation). The introduced cases of smart service systems illustrate this advancement.

## 16.3 Definitions and Characteristics of Smart Service System

Smart service systems are described with keywords such as learning, adaptation, monitoring, decision making, sensing, actuation, coordination, communication, control (NSF 2016), viability, open, optimization, intelligence (De Santo et al. 2011), compliance, sustainability, data analytics, cognitive system, service (Spohrer and Demirkan 2015), self-reconfiguration, ICT, connection (Carrubbo et al. 2015), wise, interacting (Oltean et al. 2013), people, AI, real-time, interconnected, interactivity, context awareness, proactive, preventive, IT (Gavrilova and Kokoulina 2015), self-detection, self-diagnostic, self-corrective, or self-controlled (Maglio and Lim 2016). Sectors that incorporate smart service systems include city, government, (e.g., smart city) (Lim et al. 2018e), health (e.g., smart healthcare) (Mukherjee et al. 2014), energy (e.g., smart grid) (Strasser et al. 2015), transportation (e.g., smart car) (Pelletier et al. 2011), and even manufacturing (e.g., smart factory) (Lee et al. 2014).

Table 16.1 lists the definitions or descriptions of smart service system. These definitions and descriptions are consistent in that they specify capabilities or requirements of smart service system (e.g., the capability of self-adaptation and requirement of technology incorporation) but emphasize different capabilities or requirements. A common requirement emphasized by most studies is intensive data use. Using this observation as basis, we can understand smart service systems are data-based service

**Table 16.1** Definitions or descriptions of smart service system

| Source | Definition or description |
|---|---|
| NSF (2016) | A "smart" service system is a system that amplifies or augments human capabilities (Ng 2015) to identify, learn, adapt, monitor and make decisions. The system utilizes data received, transmitted, or processed in a timely manner, thus improving its response to future situations. These capabilities are the result of the incorporation of technologies for sensing, actuation, coordination, communication, control, etc. |
| Barile and Polese (2010) | Smart service systems may be intended as service systems designed for a wise and interacting management of their assets and goals, capable of self-reconfiguration (or at least of easy inducted re-configuration) in order to perform enduring behavior capable of satisfying all the involved participants in time. . . . Because smart service systems inevitably involve multiple actors, the organizational configurations need to take account of network theory—especially the networking forces and enablers required to keep the system tight and focused towards its goals |
| Medina-Borja (2015) | A smart service system is a service system capable of learning, dynamic adaptation, and decision making based upon data received, transmitted, and/or processed to improve its response to a future situation |
| De Santo et al. (2011) | Smart service systems are open, according to the logic of viable system approach, and capable of simultaneously optimizing the use of resources and improving the quality of the services provided. ... In this sense the intelligence of smart service systems derives not from intuition or chance, but from systemic methods of learning, service thinking, data collection, rational innovation, social responsibility and networked governance |
| Spohrer and Hamid (2015) | In the era of cognitive systems, smart service systems will increasingly include cognitive or digital assistants (e.g., Watson and SIRI-like systems) for all occupations and societal roles. It is foreseeable that smart Service Science research focus on leveraging advances in AI, big data-enabled intelligence and cognitive computing, and innovating to enable the creation of intelligent technologies and societies that are integrating well with human societies |
| Spohrer and Demirkan (2015) | Smart service systems are ones that continuously improve (e.g., productivity, quality, compliance, sustainability, etc.) and co-evolve with all sectors (e.g., government, healthcare, education, finance, retail and hospitality, communication, energy, utilities, transportation, etc.). ... Because of analytics and cognitive systems, smart service systems adapt to a constantly changing environment to benefit customers and providers. Using big data analytics, service providers try to compete for customers by (1) improving existing offerings to customers, (2) innovating new types of offerings, (3) evolving their portfolio of offerings and making better recommendations to customers, (4) changing their relationships to suppliers and others in the ecosystem in ways their customers perceive as more sustainable, fair, or responsible |
| Spohrer (2013) | Smart service systems are instrumented, interconnected, and intelligent. Instrumented means sensors, sensors everywhere—more of the information (real-time and historical, as well as monte carlo predictive runs) that stakeholders, providers, customers, governing authorities, |

(continued)

**Table 16.1** (continued)

| Source | Definition or description |
|---|---|
| | etc.—need to make better win-win (value co-creation, capability co-elevating) decisions is available. Interconnected means people have easy access to information about a particular service system, as well as others that interact with it via value propositions, perhaps displayed on their smartphones. Intelligent means recommendations systems that work to provide stakeholders useful choices—for example, Watson-style recommendation systems, or Amazon-style recommendation systems |
| Carrubbo et al. (2015) | Smart service systems can be understood as service systems that are specifically designed for the prudent management of their assets and goals while being capable of self-reconfiguration to ensure that they continue to have the capacity to satisfy all the relevant participants over time. They are principally (but not only) based upon ICT as enabler of reconfiguration and intelligent behavior in time with the aim of creating a basis for systematic service innovation (IfM IBM 2008) in complex environments (Basole and Rouse 2008; Demirkana et al. 2008). Smart service systems are based upon interactions, ties and experiences among the actors. Of course, among these actors, customers play a key role, since they demand a personalized product/service, high-speed reactions, and high levels of service quality; despite customer relevance, indirectly affecting every participating actor, smart service systems have to deal to every other actor's behavior, who's expectations, needs and actions directly affect system's development and future configurations. The smarter approach applied to healthcare is called "smarter healthcare". As IBM highlights, a smarter healthcare system is obtained through better connections for faster, more detailed analysis of data |
| Oltean et al. (2013) | Smart service systems may be intended as service systems designed for a wise and interacting management of their assets and goals and capable of self-reconfiguration in order to perform enduring behavior capable of satisfying all the involved participants in time |
| Massink et al. (2010) | Common recurring elements of smart service systems are: spaces; displays; sensors; users. Users will interpret information on displays and carry out actions as a result of what has been read |
| Lim et al. (2016) | Smart service systems are those service systems in which connected things and automation enable intensive data and information interactions among people and organizations that improve their decision making and operations. Thus, transforming a service system into a smart service system means improving the decision making and operations within the service system with connected things and automation. As the definition indicates, a smart service system consists of four components: (1) connected things, (2) automation, (3) people and organizations, and (4) data and information interactions |
| Gavrilova and Kokoulina (2015) | The term "smart" implies two main properties. First, it highlights anthropomorphic features of the smart service. For example, technology research company Gartner, Inc. claims that smart technologies are ". . . technologies that do what we thought only people could do. Do what we thought machines couldn't do" (Austin 2009). Second, term "smart" is usually related to artificial intelligence (i.e. intelligence of |

(continued)

**Table 16.1** (continued)

| Source | Definition or description |
|---|---|
| | machine) "[. . .] because it is impractical to deploy humans to gather and analyze the real-time field data required, smart services depend on "machine intelligence" (Allmendinger and Lombreglia 2005). ... Smart service systems often have the following characteristics of the intelligent system: Self-configuration (or at least easy-triggered reconfiguration) (Barile and Polese 2010), Proactive behavior (capability for prognosis or preventive actions, as opposed to the reactive behavior) (Allmendinger and Lombreglia 2005), Interconnectedness and continuous interactivity with internal and external system elements (Gershenfeld et al. 2004). ... Smart service attributes include dynamic properties (without modelling of the changing environment; past-based modelling; stochastic modelling), intelligence (knowledge-based; data-based; content-based), Knowledge awareness (context-oriented; explicit knowledge; business intelligence), IT platform (mobile; SaaS; hybrid cloud; corporate servers), and elements (IT; people; hybrid) |
| POSTECH IME (2016) | A smart service system refers to a system that delivers various services effectively and efficiently by considering the needs and context of stakeholders through smart technologies. Smart service systems providing smart service offerings such as adaptive control, prognostic monitoring, personalized guidance, and user-friendly interfaces are flourishing in business and society |

systems, in which data use contributes significantly to value creation. "Smart" modifies behaviors and operations of people, operations and condition management of organizations and things, and interactions within the service system. Sensing from things and people within the service system produces data that indicate these behaviors, operations, conditions, and interactions. Data analytics contributes to the effectiveness and efficiency of these processes. Data analytics is core to smart service systems given the capability for continuous monitoring and learning with data. For instance, customer data may be converted into information that is useful in customer value creation processes in service systems and also can be used to adjust service operations (e.g., use of energy usage data for energy management). Imagining a smart service system without intensive use of data is difficult. Thus, a key to transform service systems into smart ones lies in exploiting data.

## 16.4 Design and Development of Smart Service System

The findings from the previous sections show that a smart service system features a data-based value creation mechanism. Previous studies on the design and development of smart service systems provide further insights into data-based value creation mechanisms of smart service systems. This section briefly introduces findings from the studies in Table 16.2.

**Table 16.2** Studies on the design and development of smart service system

| Study | Brief description | Related service system |
|---|---|---|
| Lim et al. (2018a) | Designed car infotainment services for individual drivers that use vehicle operations and condition data, based on analyses of 7.6 million trip data of 18,943 vehicles (vehicle operations data) and 3662 cases of warning code occurrences (vehicle condition data) | Smart transportation |
| Lim et al. (2018d) | Designed driving safety enhancement services for commercial drivers that use vehicle operations data, based on analyses of operations data of commercial vehicles (278 buses, 46 taxis, and 931 trucks) and accident data of commercial vehicle drivers (4289 bus, 1550 taxi, and 490 truck drivers) | |
| Kim et al. (2018) | Designed an eco-driving support service for bus drivers that use vehicle operations data, based on analyses of bus operations and fuel consumption data of 33 bus drivers | |
| Winkler et al. (2016) | Designed and implementing a thermal comfort enhancement service for building occupants that uses building energy operations data and occupant feedback data | Smart building |
| Kim et al. (2014a) | Designed hypertension patient management services that use a national health insurance database, based on analyses of a sample data from the database for one million people for 9 years (2002–2010) | Smart health |
| Kim et al. (2016) | Designed a smart wellness service for college students that use daily behavior data of students, with an IT company and a student counseling center at a university based on data from 47 students | |
| Kim et al. (2014b) | Designed health-related data-based services for health-related stakeholders with a government organization, based on interviews with 34 experts such as doctors, public health scientists, managers and executives in the industry, and government employees | |
| Chung and Park (2016) | Proposed a personal health record (PHR) open platform based smart health services using the distributed object group framework for managing chronic diseases | |
| Yu et al. (2011) | Designed a home portal service with a smart door interface which combines virtual and physical door control and provides the place for home members to communicate each other no matter he is at home or not | Smart home |
| Cai and Li (2014) | Designed a micro grid renewable energy service system for an island that uses wind, photovoltaic and biomass energy | Smart energy |
| Perera et al. (2014) | Proposed a “Sensing as a Service” model based on IoT infrastructure for smart cities, such as waste management and smart agriculture services | Smart city |
| Maglio and Lim (2016) | Categorized design models of smart service system into four groups according to the source and usage of data: smart operations management, smart customization and prevention, smart coaching, and smart adaptation and risk management services | Any smart service system |

From these studies, we can derive a generic mechanism of data-based value creation in smart service systems. Each study focused on a specific part of the spectrum from data to value creation in smart service systems. Considering these studies, smart service systems, regardless of cases, entail the collection of data from certain sources, creation of useful information on the data sources through data analysis, and delivery of information to users to help them create value. More specifically, data-based value creation in smart service systems involves at least nine factors: (1) data source, (2) data collection, (3) data, (4) data analysis, (5) information on the data source, (6) information delivery, (7) information user, (8) value in information use, and (9) provider network (Lim et al. 2018b).

Data source (factor 1) includes specific objects such as vehicles, facilities such as city infrastructure, management activities such as city administration, and customers such as drivers and citizens. The methods of data collection (factor 2) include using sensors, recording logs of IT system users, and crowdsourcing of opinion data. Data (factor 3) include condition traces of engineering systems, event logs of business systems, health and behavioral records of people, and bio-signals of animals. The methods of data analysis (factor 4) include using specific algorithms pre-installed on servers and expert knowledge, which entail time for decision making.

Information (factor 5) created from data analysis indicates interested facts about the original data source. In many cases, the terms "data" and "information" are used interchangeably. For smart service systems, this chapter distinguishes data from information based on the data–information–knowledge–wisdom (DIKW) hierarchy (Braganza 2004): Data are raw materials and ingredients of information, and information is the outcome of the data analysis used for a specific purpose (Lim and Kim 2015). The methods of information delivery (factor 6) include e-mail, phone calls, smartphone applications, or onboard displays in vehicles (Lim and Kim 2014). Information user (factor 7) includes drivers who use car infotainment services, parents who utilize baby-monitoring services, and citizens and local organizations that use services in smart cities. A common aspect of these studies in Table 16.2 is that each study focused on specific stakeholders (i.e., information users) of a service system as main targets for data-based value creation, such as passenger car drivers (Lim et al. 2018a), riders and drivers of commercial vehicles (Kim et al. 2018), building occupants (Winkler et al. 2016), and people and government (Kim et al. 2014a, b).

Examples of value (factor 8) include evidence-based health management, improvement of operational processes of certain service systems, and prevention of potential user problems. Note that value is not created until users actually use the received information for a specific purpose. In other words, value is created in information use (Vargo and Lusch 2004; Lusch and Nambisan 2015). For example, the safety of driving can be improved when information for safe driving is used by drivers and health can be improved when health-related advice information is used. The provider network (factor 9) consists of the main service provider (which interacts with customers) and its outsourcing partners, such as sensor manufacturing, data management, and analytics companies. Data and information can be digitized

into bits unlike other types of deliverables in business; thus, outsourcing is common in smart service systems.

A service concept is a description of what needs to be done for customers and how this can be done (Edvardsson and Olsson 1996; Goldstein et al. 2002; Kim et al. 2012). Thus, designing services requires understanding the things that constitute the what and how of service (Lim et al. 2012; Kim et al. 2013). Service design is difficult because a design space is wide and complex, which is attributed to the variety of the what and the how of the candidates (Lim et al. 2018c). The nine factors embrace key areas of smart service system analysis and design: (5) what to deliver, (8) why, (7) to whom, (1–4) how to produce it, (6) how to deliver it when and where, and (9) who creates and delivers it. The use and management of data in smart service systems should consider these areas to facilitate value creation with.

## 16.5 Understanding Smart Service System Through Text Mining

Including the intensive use of data discussed in the previous sections, smart service systems involve diverse features. The functions and operations of smart service systems depend on sensing (Sim et al. 2011), big data (Maglio and Lim 2016), computation (Lee et al. 2012), and automation (Jacobsen and Mikkelsen 2014). Customer (Wuenderlich et al. 2015) and business aspects (San Roman et al. 2011) must be considered as well. A search for "smart service system" in the Web of Science generates more than 5000 results across engineering, computer science, information systems, control, transportation, healthcare, and other fields. Given the wide range of various research related to smart service systems, a unified understanding of the concept across different fields may facilitate development and innovation; such unification would promote the use, integration, and improvement of technologies from a broad and application-oriented perspective. However, such integrative work is difficult to achieve because of the variety and number of studies and applications related to smart service systems. Text mining is an appropriate method to address this challenge given its ability to automatically explore aspects and areas of smart service systems in a comprehensive manner (Lim et al. 2017).

Lim and Maglio (2018) developed a unified view of smart service systems by mining text related to these sorts of systems. The text they analyzed includes scientific literature, news articles, and user opinions. Their analytics method uniquely incorporates metrics to statistically measure the importance of word-features of data and unsupervised machine learning algorithms, such as spectral clustering (Von Luxburg 2007) and topic modeling (Blei et al. 2003), to capture the essence of the data. Their analysis of 5378 scientific studies, 1234 news articles, and 444 opinion surveys identifies statistically significant keywords, research topics, technology factors (sensing, connected network, context-aware computing, and wireless communications), a definition, application areas, and end-user-perceived

values. This section briefly reviews their findings to advance the readers' understanding about smart service systems after the previous sections.

Findings from the analysis of 5378 literature data indicate that a smart service system requires technologies for networking, data and information processing, control, communications, devices, and applications to provide specific functions to system users. Related topics in the literature include "design of smart service systems," "sensing," "Internet/Web of Things," "wireless networks/communications," "mobile devices," "cloud computing/environment," "security," "smart home," "smart health," "smart energy management," and "smart city." Lim and Maglio (2018) also identified a set of 53 generic word-features that may represent the generic structure of smart service systems, including "thing," "internet," "context-aware," "control," "sensing," "wireless," "location," "access," "communication," "computing," and "data." An exploratory factor analysis of the 53 generic word-features of 5378 articles from the literature (i.e., those extracted from the 5378 by 53 matrix dataset that may represent the generic structure of smart service systems) revealed four key technology factors of (any) smart service systems; based on factor loading of the 53 word-features (i.e., variables), these four factors can be called "connected network," "sensing," "context-aware computing," and "wireless communications."

Using the four factors and the list of 53 generic words as basis, Lim and Maglio (2018) propose a statistically significant definition of smart service system: "A smart service system is a service system that controls things based on the resources for connected network, sensing, context-aware computing, and wireless communications". Examples of the resources include specific environments, infrastructure, devices, and applications (software). Examples of the things to be controlled include specific objects, processes, and users. These definitions and examples are meaningful in that they consist of the important words quantitatively identified from the literature data.

Findings from the analysis of 1234 news data indicate that application areas of smart service systems can be categorized into "smart device," "smart environment," "smart home," "smart energy," "smart building," "smart transportation," "smart logistics," "smart farming and gardening," "smart security," "smart health," "smart hospitality," "smart education," and "smart city and government." These 13 areas can be distinguished according to the type of application: Smart device and environment are resource-type areas, which are required in any kind of smart service system. Smart home, energy, building transportation, logistics, farming and gardening, security, health care and management, hospitality, and education are business system-type areas. Smart city and government systems are a public administration-type area. Common keywords found from the news data include "device," "product," "app," "data," and "information." This list implies that the essence of smart service systems, which have been discussed in various news articles, is the use of a device or product with a smartphone application to collect data from people and to deliver information to them. A network analysis of these areas indicate that a smart service system is related to other systems across different contexts of the users (e.g., smart health and smart home are highly relevant, while smart transportation is one of the key businesses in smart cities) and resources (e.g., smart device and

environment). Thus, achieving synergy between different smart service systems will effectively streamline the development and operations of a system.

Findings from the analysis of 444 user opinion data indicate that people used the following phrases to describe values of the smart service system they like: “ask Siri thing,” “easy order,” “people make money,” “behavior make decision,” “computer make choice,” “people living assisted,” “advance contextual awareness,” “better sleep tracking,” “monitor many different,” “ready go get,” “people want know,” “house living remotely,” “allowing happen without,” “accomplished less time,” “ability reduce load,” “make job,” “manage human resource,” and “surroundings make decision.” Based on this result and a detailed reading of the full list of 444 opinion data, we found that the end-user-perceived values of smart service systems may include (1) save time, cost, or other resource; (2) reduce undesired outcomes; (3) increase desired outcomes; (4) allow things to happen without something; (5) monitoring or tracking ability; (6) know the user or the contexts; (7) easy or autonomous decision making; and (8) easy order or remote control.

Combining all the findings, Lim and Maglio (2018) describe smart service systems, such as smart homes and health, energy, transportation, and hospitality systems, as follows: Smart service systems automate or facilitate the value-creating activities of users and providers based on technological resources for connected network, sensing, context-aware computing, and wireless communications. These systems enable users to get their jobs done efficiently and effectively. Sensing of data obtained from connected networks of people and things is the key mechanism of smart service systems. Context-aware data analysis creates information that can be used by users to manage and improve their things (e.g., specific objects, processes, and resources) and people concerned. User-friendly smart devices enhance the delivery of benefits of smart service systems to users through wireless communications. The design of a smart service system can be improved by considering the factors and values of the system in question and seeking a synergy with other application areas.

## 16.6 Clarification of the Concept of Smart Service System

Each of the previous sections emphasized specific characteristics of smart service systems. Section 16.2 emphasized the importance of sensor data collected from connected things and people. Section 16.3 emphasized that capabilities of smart service systems require a data-based mechanism. Section 16.4 emphasized the importance of managing the spectrum from data to value creation in smart service systems. Section 16.5 emphasized the four technology factors required to create value, namely, connected network, sensing, context-aware computing, and wireless communications.

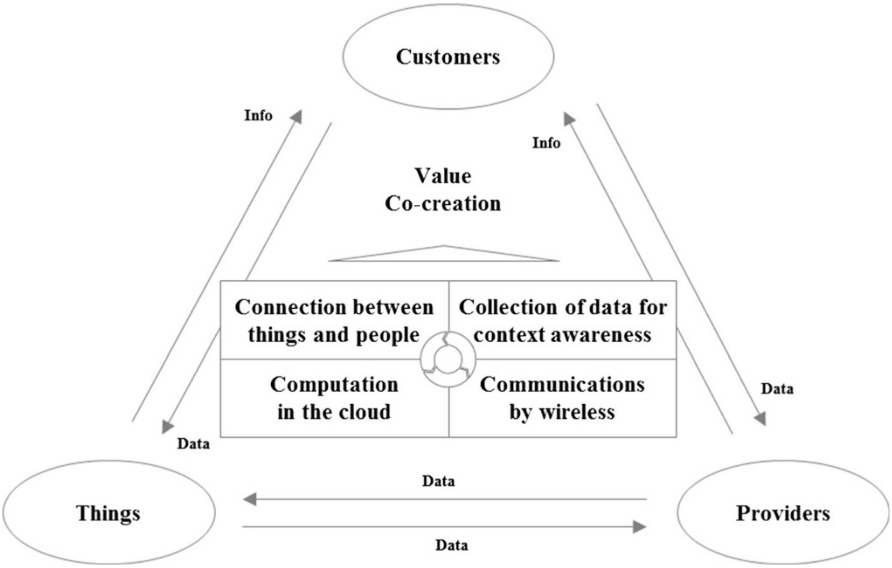


**Fig. 16.1** Conceptual framework of smart service system

By integrating findings from the previous sections, this section aims to clarify the concept of smart service system. Smart service systems are service systems in which value co-creation between customers, providers, and other stakeholders are automated or facilitated based on a connected network, data collection (sensing), context-aware computation, and wireless communications. These systems enable customers to accomplish their tasks efficiently and effectively. Using data from people and things (e.g., specific objects, processes, and resources) is the key in smart service systems to manage and improve the value co-creation and system operations. Given this definition, a smart service system exhibits five essential attributes, namely, the 5Cs: (1) Connection between things and people, (2) Collection of data for context awareness, (3) Computation in the cloud, (4) Communications by wireless, and (5) Co-creation of value.

Figure 16.1 illustrates a conceptual framework of a smart service system based on the 5Cs. Customers and providers who are connected to each other co-create value through data and information communications. Data are collected from connected things (e.g., specific objects, processes, and resources), customers, and providers and then transformed into information through computational processes. Information generated from computational processes is used by the customers to use, manage, and improve their concerned things and people.

Connection between things and people is the first attribute that a smart service system should manage. Connected things include tangible goods directly used by customers, as well as dedicated infrastructures generally required by customers and providers; these goods and infrastructures can be connected to other things. We live in a connected world; the buzzwords “IoT,” “Connected Car,” or “Connected

Home" reflects our ability and desire to effectively control things around us. The development of a connected network of people and things, which is the base infrastructure for a system, is the groundwork for collection and communications in a smart service system. In fact, a connected network represents the network of "data sources" for smart service systems. Where to collect data is directly relevant to data use (i.e., purpose of service system) and to the scope and potential of a service system. IoT is crucial because IoT is about creating a cyber-physical infrastructure for connection. Technologies for data analytics, cloud computing, and mobile communications, among others, can effectively work together only with a connection infrastructure.

Collection of data from connected people and things is the second attribute of a smart service system. Data include condition traces of engineering systems, event logs of business processes, health and behavioral records of people, and bio-signals of animals. Given our capability for continuous monitoring and learning from data, data are the core resources for context awareness. The term "smart" pertains to information actions rather than to physical or interpersonal actions; hence, this term is inevitably related to the use of data. A major distinction between traditional and recent data collection is the data source (i.e., engineering systems versus human systems). Current sensing methods include physical plus social sensing. Physical sensing refers to a process conducted using physical sensors, whereas social sensing includes any type of sensing enabled or conducted by people without using physical sensors. Examples of social sensing include data collection from social network services, surveys, interviews, queries, and documents. Physical and social sensing from things and people within a service system produce data that indicate behaviors and operations of people, operations and condition management of organizations and things, and interactions within a service system. Data use contributes in the effectiveness and efficiency of these processes.

Computation is the third key attribute of a smart service system. Computational processes involve the use of specific algorithms and expert knowledge for decision making. Computation is the prerequisite for data and information communications in a connected network because these processes transform raw data into standardized data or information that enable machine-understandable data or human-understandable information. The key functions of smart service systems (e.g., context awareness, predictive and proactive operations, adaptation, real-time and interactive decision making, self-diagnosis, and self-control) can be created only through computation of specific data. This often requires several pre-tasks for data analytics, such as analysis planning, data cleaning, anonymization, aggregation, integration, and storage. Two of the key requirements of computation in smart service systems are cloud computing availability and security because of the distributed nature of connections in the service system.

Communications by wireless between people and things is the fourth attribute of a smart service system. The contexts of communications include machine-to-machine actuation and machine-to-human guidance. Thus, the issues of this attribute encompass the issues in communicating machine-understandable data and human-understandable information, such as visualization methods and other information

delivery methods through auditory, olfactory, palate, and tactile stimulation in physical, virtual, and augmented reality. Although the same goods, infrastructures, and stakeholders can be involved in multiple service systems, interactions are relatively unique in each service system. Although technologies for connection, collection, and computing are fulfilled in a specific service system, the key to transforming such system into a smarter service system or to creating a new smart service system lies in improving the unique interactions within the system in question. As such, communications technology that facilitates interactions is crucial in any smart service system and is considered the circulating blood of the system.

Co-creation of value between customers and the provider of a service system is the fifth attribute of a smart service system. Value creation is the core purpose and central process in economic exchange. Any type of socio-technical service system involves value co-creation that brings different stakeholders together to jointly produce a mutually valued outcome. In this respect, the development and use of technologies ultimately aim for enhanced or new value creation. Examples of value co-creation stakeholders include customers of IT goods, manufacturers, government agencies of infrastructure, and application developers. The first four attributes represent the technological resources for smart service systems, whereas the fifth attribute represents the application objective of various resources. In fact, the first four attributes of smart service systems contribute to increasing the opportunities for active value co-creation. As we become more connected, encounters for value co-creation increase; as we collect and compute more quality data (quality in terms of variety and volume), the informational or intellectual resources for value co-creation increase; and as we communicate more efficiently and effectively, the frequency and intensity of value co-creation increase.

Figure 16.1 indicates that smart service systems have a closed-loop mechanism. Data and information interactions within a service system are iterative, and stakeholders can develop their relationships and improve value co-creation continuously through a cycle of monitoring and learning. This feature shows the true importance of service system thinking for the use of various technologies. The direction of the evolution of smart service systems is clear, that is, continuous development of the loop of value co-creation by integrating technologies for connection, collection, computation, and communications. The real advantage of service system thinking is that it deviates from the existing technology concepts and focuses on the final function (i.e., application) that must be fulfilled.

The 5Cs are useful in describing and analyzing a smart service system. For example, a smart home can be defined as a service system that automates or facilitates value co-creation activities (e.g., lighting, cooking, temperature control, garage opening, and exercising) between residents and related stakeholders through in-home or home-around connectivity, collection of living-related data, computation for context awareness, and wireless communications achieved within or through a technology-equipped house. Similarly, a smart health service system automates or facilitates value co-creation activities among patients, healthy people, healthcare providers, and other stakeholders through connectivity among people, devices, and healthcare environment; collection of health-related data; computation for diagnosis

and prognosis; and communications within or through technology-equipped people, living, and care environment.

Another significance of describing smart service systems in this manner is that the 5Cs provide a basis for interconnecting different fields, with emphasis on applications. Recent concepts, such as IoT, big data management, AI, cloud computing, and wearable devices, are related to smart service systems, wherein each concept corresponds to one or more system attributes. For example, wearable devices (e.g., smartphones, wristbands, and watches) are related to collection and communications and serve mainly as data collection and information delivery channels. AI is related to computation, whereas IoT is about connection. Moreover, each of the research fields related to smart service systems, for instance, electronic engineering on collection and communications, computer science on computing, and marketing and business on co-creation, may focus on one or some of the system attributes and seek synergy with different fields related to other attributes. A challenge for R&D projects is the integration of the expertise of different professionals into knowledge for value creation. The proposed concept of smart service system with its five attributes can guide the entire project team to work effectively in managing and improving a technology-based service system.

## 16.7 Categorization of Smart Service System

The conceptual framework of smart service system illustrated in Fig. 16.1 shows how technologies contribute to the interactions and value co-creation within a network of customers, providers, and things. By integrating the framework and related studies on service categorization (Frei 2006; Bolton and Saxena-Iyer 2009; Campbell et al. 2011; Wünderlich et al. 2013) and value co-creation (Payne et al. 2008), we can categorize different smart service systems into three types, namely, smart self-service, smart super service, and smart interactive service systems (see Fig. 16.2).

Payne et al. (2008) developed a process-based conceptual framework for understanding and managing a detailed mechanism of value co-creation. Their framework shows that customer value is co-created based on continuous interactions between customer and provider processes through encounter processes. From this perspective, services can be differentiated according to the portion of customer roles in value co-creation processes. In traditional self-services or classic reduction of customer variability (Frei 2006), such as the use of ATM and self-check-in hotels, the customer performs many of the tasks previously done by the provider. By contrast, the boundary can shift in the opposite direction. In traditional super services (Campbell et al. 2011) or classic accommodation of customer variability (Frei 2006), the provider performs many tasks previously done by the customer, such as a car rental service that delivers cars to customers or luxury hotel service. Meanwhile, in traditional interactive services (Bolton and Saxena-Iyer 2009), such as fitness

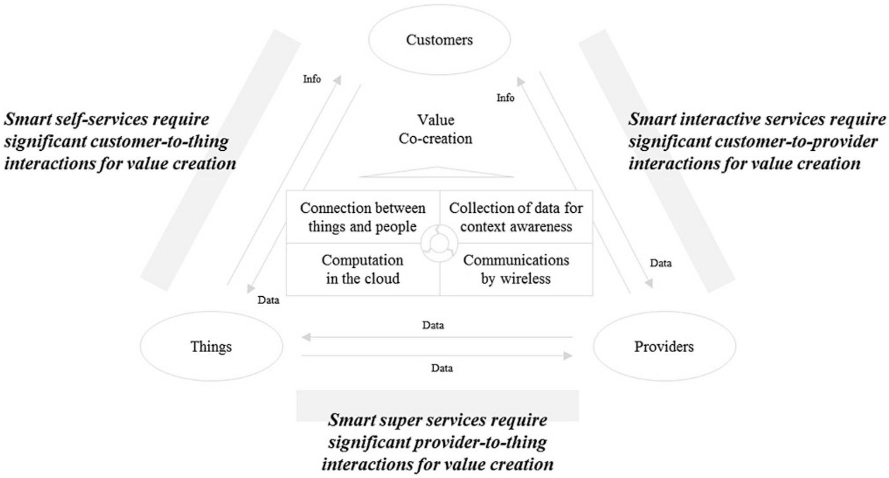


**Fig. 16.2** Three types of smart service system

training and counselling services, interpersonal interactions between customer and employee are essential for value co-creation.

The four technology factors of smart service system (i.e., connection, collection, computation, and communications) have advanced all three types of service. For example, smart band-based fitness tracking services (Takacs et al. 2014) take the traditional role of fitness trainers and enable a smart self-service system for health management powered by the four technology factors (e.g., coaching capability for people). Such smart self-service systems require significant customer–thing interactions for value creation. By contrast, many equipment manufacturers take the traditional role of customers in maintaining and using equipment and enable a smart super service system powered by the four technology factors (e.g., optimization capability for equipment). Such smart super service systems significant provider–thing interactions for value creation. Meanwhile, a smart interactive service system "comprises not only an embedded technology within the product that communicates object-to-object but also personal interactions between the user and the service provider employee as part of the smart service delivery process" (Wünderlich et al. 2013). Examples include industrial remote interactive repair and online transportation network (e.g., Uber) services. Smart interactive service systems are somewhere in between the other two types and require significant customer-to-provider interactions for value creation.

Service systems depend not only on people, information, organizations, and technologies but also on their interactions, which have emergent consequences (Maglio and Lim 2016). Thus, managing the interactions among customers, providers, and things involved in the service system is key to improve value co-creation. Figure 16.2 shows how different types of smart service system improve the interactions with technology. Lusch and Nambisan (2015) provide a broadened view of service innovation based on the service-dominant (S-D) logic (Vargo and Lusch

2004) and describe the integration of the resources of a service system as the fundamental method to innovate the system. In the proposed conceptual framework of smart service system, the connection and communications factors mainly contribute to a tighter integration of resources (e.g., people and their concerned things), while the collection and computation factors are critical in creating new useful resources (e.g., data on the things, information for people, and enhanced knowledge of people). From this perspective, Fig. 16.2 further illustrates the three areas of technology-based service innovation: The integrative use of the four technology factors (i.e., connection, collection, computation, and communications) contribute to the smart self-service innovation by enhancing the controllability of customers over their concerned things; to the smart super service innovation by allowing providers to infiltrate into the value creation process of customers, embed themselves in the process, and take the roles previously done by the customer; and to the smart interactive service innovation by expanding and intensifying the interactions between customers and providers.

## 16.8 Future Research Topics

By integrating existing studies on smart service system in this chapter, a number of research issues have been observed. This section discusses the four following priorities: (1) service systems analytics and engineering, (2) operationalizing value co-creation in smart service systems, (3) autonomous service systems, and (4) extending the smart service system concept.

First, this chapter calls for research on service systems analytics and engineering. A system is “a combination of interacting elements organized to achieve one or more stated purposes” (ISO/IEC 2008). Human-designed systems, such as vehicles and transportation systems, have well-defined architectures and understood mechanisms of operation. For other systems, parts may be designed but the systems themselves may evolve, such as cities or universities, with system architectures and mechanisms emerging over time. Service systems tend to fall between fully designed and fully emergent systems, and their architectures or mechanisms are not yet clearly understood, although such an understanding is the key to engineering and improvement. One difficulty in engineering and managing complex service systems is the lack of data required to monitor and improve the system elements. However, with recent advances in sensing technologies, various kinds and massive amounts of data can be collected from the elements of the service system, such as people and physical goods.

This advancement contributes to unlocking the limitations of engineering and managing service systems, that is, a way of transforming specific service systems into smarter service systems. At least, the proliferation of (big) data alleviates two challenges in service systems engineering and management. First, articulating the concept, architecture, and mechanism of a service system was difficult because service systems are complex (Maglio et al. 2009) and fuzzy (Glushko 2013), in

contrast to physical systems, such as vehicles and factories. Section 16.5 illustrates how newly available text data from social sensing can be used to understand the mechanism and define the concept of a specific type of service system, that is, the smart service system. Second, designing a service system was difficult because service systems involve numerous variabilities originating from customers (Frei 2006), contexts (Glushko 2010), and operations (Roels 2014). Section 16.4 illustrates how newly available physically sensed data from customer processes or operations within the service system in question can be used to design new services or improve existing services. Transforming specific service systems into smarter service systems requires understanding of the service system in question and modification of the system operations. Under the proposed framework of smart service system, it is apparent that data analytics can contribute to such understanding and modification. Research on using data through descriptive, predictive, and prescriptive analytics will contribute to understanding and improving service systems in multiple application areas.

Second, this chapter calls for research on operationalizing value co-creation in smart service systems. Many notable studies have discussed concepts, utilities, and mechanisms of value co-creation theoretically and empirically in marketing, information systems, innovation, design, and multidisciplinary contexts (e.g., Vargo and Lusch 2004; Maglio and Spohrer 2008; Payne et al. 2008; Vargo and Lusch 2016). Despite the emergence of a broad range of research on value co-creation over the last decade, a review of the literature revealed a surprising lack of work directed at providing frameworks to help organizations operate value co-creation with customers effectively and systematically, except for few related studies (Payne et al. 2008; Ulaga and Reinartz 2011; Smith et al. 2014). The fifth axiom of S-D logic states that “value co-creation is coordinated through actor-generated institutions and institutional arrangements” (Vargo and Lusch 2016). Thus, S-D logic indicates the research necessity of operationalizing value co-creation in service settings to account for all agents, organizations, and resources involved.

One difficulty in operationalizing value co-creation is the lack of data required to track, measure, model, modify, control, and manage individual customer behavior and perceptions (Lim et al. 2018f). Considering the field of industrial operations management before the emergence of “big data,” data from production and business operations were routinely used to better operate specific processes (e.g., Linderman et al. 2003; van der Aalst and Weijters 2004). With recent advances in sensing technologies, various kinds and massive amounts of data are collected from individuals through sensor-equipped consumer electronics (Porter and Heppelmann 2014). Traditional survey or observation data on customers are essentially research data involving a hypothesis before data collection, whereas sensor data on customers are natural records being collected and archived independent of a specific research project, which reflect the real behavior and contexts of customers. From a marketing perspective, the IoT enables the Internet of Customers that creates many new types of customer touchpoints and provides opportunities for managing the customer relationship (Johnson 2016). In this context, it is the time to operationalize value co-creation with newly available data on customers.

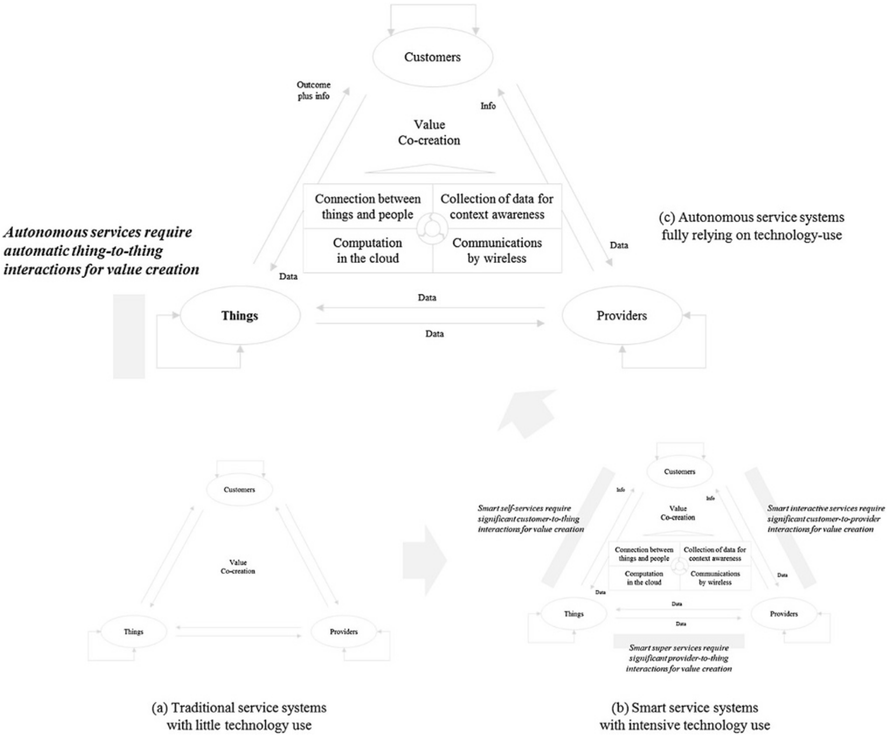


**Fig. 16.3** Evolvement of service systems and emergence of the autonomous service system

As discussed, various kinds and massive amounts of data are collected in smart service systems from sensors located around people. Such newly available data can be used for operationalizing value co-creation on the connected network. The previous section illustrates that, for effective value co-creation, smart self-services operationalize customer–thing interactions using data from customers and things, smart super services operationalize provider–thing interactions using data from providers and things, and smart interactive services operationalize customer–provider interactions using data from customers and providers. However, only few studies addressed this topic though it is key to the application of the value co-creation concept and S-D logic in practice. Although the studies reviewed in Sect. 16.4 provide some insights into smart service system operations, most of the studies do not focus on the context of value co-creation. Research on operationalizing value co-creation in smart service systems will contribute to managing and improving service systems in this connected and data-rich world from a service science perspective.

Third, this chapter calls for research on autonomous service systems. The proposed framework of smart service system can be used to describe any service system as the network of customers, their concerned things, and providers is generic. From this perspective, Fig. 16.3 illustrates the evolvement of service systems according to

the intensity of technology use in the service system network. Value is co-created through "the application of competences (knowledge and skills) by one entity for the benefit of another" (Vargo and Lusch 2004). In traditional service systems (Fig. 16.3a), customers employ the competences of providers to achieve specific goals and interact with concerned things. In the three types of smart service system (Fig. 16.3b), the interactions among customers, their concerned things, and providers are facilitated or automated based on the four technology factors (i.e., connection, collection, computation, and communications). In this continuum, a new type of service system that is rapidly emerging is the autonomous service system (Fig. 16.3c), such as service systems based on a self-driving car (e.g., Google) and a fully automated building (e.g., Edge in Amsterdam).

As shown in Fig. 16.3, interactions exist within customers, things, and providers. As recent AI can recognize and deliberate various things, we must pay specific attention to thing–thing interactions. In autonomous service systems, thing–thing interactions are fully automated and the things behave autonomously. Following Frei (2006), traditional "automation" technologies and modern "autonomous" technologies in service systems can be distinguished in terms of variability, with traditional "automation" technologies "reducing" and controlling variability (e.g., trains use specified routes and ATMs cover limited options) and modern "autonomous" technologies "accommodating" variability (e.g., self-driving cars use any route and AI-based financial services invest by themselves). Autonomy must incorporate automation technologies for the four technology factors of smart service system to be connected with, use data on, deliberate about, and communicate with humans and things. We are at a tipping point of the true integration of these factors for autonomy for monitoring, communication, context awareness, learning, predictive and proactive behavior, adaptation, optimization, real-time and interactive decision making, control, self-detection, self-diagnosis, self-reconfiguration, and self-control. As shown in Table 16.1 in Sect. 16.3, these terms have been used to describe smart service systems. Thus, the emergence of autonomous service systems means the emergence of truly smart service systems as indicated in the continuum shown in Fig. 16.3.

Autonomous service systems may be viewed as an ideal form of smart self-service systems in that customers only need to consider the outcome of the service system or the same of smart super service systems in that providers encapsulate their capability in the service system. However, autonomous service systems are clearly different for the adjacent types shown in Fig. 16.3 in that no or a minimum level of human–thing interactions is required and things take deliberate action on their own. Given a full automation of the interactions within things and consequent autonomous behavior and operations of the things, customers and providers (nearly) do not have to interact with each other and with the things.

In autonomous service systems, value co-creation processes are nearly automated by the things as humans only need to take (either consciously or unconsciously) the value in use produced and delivered by the things automatically. Many areas of smart service system, such as autonomous farming, building, energy, logistics, transportation, and security, can be evolved into autonomous service systems,

whereas smart home, health, hospitality smart education, smart city, and government service systems require human interventions. In any case, what should be automated or whether and when automation will improve the overall value co-creation (or it should only be value creation) is unclear. Research on autonomous service systems from a service science perspective can extend the literature on value co-creation to the world of interactions within things and improve the partnership between humans and computers for value co-creation.

Finally, the smart service system concept proposed in this chapter should be further extended and studied in depth. This chapter has mainly focused on a digital data-centric perspective, such as that on the connection of different data collection sources to develop a smart service system with high-quality computation and communications functions for value co-creation. However, this perspective may be incomplete due to the limited scope of the reviewed studies on smart service systems and the authors' limited background in industrial engineering, computer science, and management. For example, this chapter has not fully covered the engineering perspectives on physical human–machine interaction (HMI) as well as those on physical control and actuation mechanisms. Within most of the existing smart service systems, humans interact with machines. Using advances in haptics and actuators enhances the interactions between them and improves function execution accuracy. For example, the ability to physically retrieve cash from an ATM or deposit a check may co-create more value than the action of checking the balance only. Thus, advancements in the HMI and control aspects of ATMs are important. The future AI-based smart banking service systems are not different and are required to be equipped with high-quality functions for HMI and controls. This requirement applies to other types of smart service system as well, such as physical driving with received information in smart transportation systems and physical intervention in smart health systems, which are adaptive to the patients' behavioral and bio-signal data. These perspectives are also important in autonomous service systems because humans are always involved and receive physical outcomes in such systems.

Our intention was not to propose an exhaustive concept of smart service system in one chapter but to clarify some important perspectives and elements of the concept. Value co-creation in smart service systems can be enhanced by advances in data collection and use, but also through the spectrum of engineering advances in actuation, such as a robotic hand exoskeleton that can provide an assistant service to a customer by reacting to the input provided through the electromagnetic waves from the customer (e.g., electromyography; Yun et al. 2017a, b). In general, the physical interaction of a machine with a human to co-create value is only possible because of the existence of both elements.

Although we believe the aforementioned perspectives are important, we could not state these perspectives in an earlier section because we could not find these from our data analytics and specific references focused on the smart service system concept. For example, in the factor analysis discussed in Sect. 16.5, we could not derive a control-related factor when we set up the number of factors as five or six, though "control" was one of the 53 generic word-features that may represent the generic structure of smart service systems. We believe future studies on the HMI and control

aspects of smart service systems can extend our findings significantly. For example, factors about the physical actuators and physical interaction with technology can be added to the current nine factors of value creation mechanisms of smart service systems. The 5Cs can also be further extended to the 6Cs, including the following: (1) Connection between things and people, (2) Collection of data for context awareness, (3) Computation in the cloud, (4) Communications by wireless, (5) Control and actuation of physical elements, and (6) Co-creation of value. Smart service systems with a strong physical component, such as smart homes, transportation, and farming, may be described and developed with the extended 6Cs concept.

Likewise, other perspectives on smart service systems can be further investigated and added to the findings of this chapter. The level of service system smartness should also acknowledge the partnerships between machines and humans that interact to co-create value. For example, a team consisting of robotic assistant nurses, human nurses, human doctors, and surgery robots can co-create value with patients as they deliver smart health services to such patients. Strategies for the symbiosis, where the machine and the human interact in a perfect and harmonic way, should be studied and included in an extended smart service system concept. Indeed, no machine can complete the value co-creation process without the human, and no human can do it without the machine. Finally, the augmentation of human capabilities, such as vision, sensing, touching, hearing, and movement in smart service systems, can be investigated and integrated with all the aforementioned points.

## 16.9 Conclusion

This chapter takes a service science perspective in viewing service systems in this connected and data-rich economy, following the call for proposals on smart service systems by the NSF (2016). The concept of smart service system discussed in this chapter recognizes the smartness in modern service systems as multi-dimensional (i.e., the 5Cs). The concept can facilitate the application of a service science perspective to develop and use technologies for people for their value co-creation. Our work is significant in that the findings were derived from a literature review (Sect. 16.3), real projects with industry and government on the design and development of smart service systems (Sect. 16.4), and an analytics of 5378 scientific studies and 1234 news articles (Sect. 16.5). The findings in Sects. 16.6 and 16.7 aggregate the key concepts and areas of broad studies and applications of smart service system. Our work will bring significant clarification and elaboration to the definition of smartness in modern service systems. Smart people co-create value by creating connections between relevant things and the concerns of people, by collecting and computing data, and by communicating with things and people to address the concerns. This mechanism can be applied to describe and develop any type of smart service system. Following Larson (2016), the authors believe that this chapter would provide an effective framework for the design and development of smarter service systems across multiple disciplines.

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# Chapter 17
# Exploring the Journey to Services

**Veronica Martinez, Andy Neely, Chander Velu, Stewart Leinster-Evans, and Dav Bisessar**

**Abstract** Firms are increasingly providing services to complement their product offerings. The vast majority of studies on the service journey, also known as servitization or service transition, examine the challenges and enablers of the process of change through cases studies. Investigations that provide an in-depth longitudinal analysis of the steps involved in the service journey are much rarer. Such a detailed understanding is required in order to appreciate fully how firms can leverage the enablers while overcoming the challenges of servitization. This study investigates what does a service journey look like? It analyzes in some detail the actual service journeys undertaken by three firms in the well-being, engineering and learning sectors. The paper offers four original contributions. First, in the change literature, there are two dominant theories: The punctuated equilibrium model and the continuous change model. This study demonstrates that servitization follows a continuous change rather than a punctuated equilibrium. It shows that such continuous change is neither logical nor structured but much more emergent and intuitive in nature. Second, the study provides empirical evidence to support a contingency view of the dominance and sequencing of the different process models of change across the change journey. Third, this research shows the pace of service development and when the coexistence of basic, intermediate and complex services occurs. Finally, it contributes to the literature in the service field by presenting three actual service journeys and the associated seven stages of the service strategy model that organizations should consider when managing their service journeys. To the best of our knowledge, this is the first study that shows when in the journey firms start launching a combination of different types of services.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_17

**Keywords** Sevitization · Services · Transformation · Business Models

## 17.1 Introduction

Increasingly, manufacturing firms are diversifying and expanding their strategies into services (Raddats et al. 2016; Martinez et al. 2017). Globally, over a third of large manufacturing firms offer services, with two out of three in developed countries doing so (Bowen et al. 1989; Neely 2008; Visnjic et al. 2013; Cusumano et al. 2015). Moreover, studies have shown that manufacturers generate, on average, one-third of their revenue from services (Fang et al. 2008). Despite the prevalence of services among manufacturing firms, many struggle to manage the transition from product-centric to service-centric business (Bintner et al. 2008; Reinartz and Ulaga 2008; Spring and Araujo 2009; Chesbrough 2010; Ng et al. 2013; Baines et al. 2016). Delivering services requires different operating processes, capabilities, platforms, accountabilities and orchestration of resources that differ from those commonly used to deliver products (Story et al. 2016; Eloranta and Turunen 2016). The aim of this paper is to advance our understanding of the journey that firms undertake in their transition to supplement their products with services.

Servitization is the process by which product providers add complementary services to their product proposition (Vandermerwe and Rada 1988; Neely 2008). Manufacturing firms have increasingly been servitizing as the result of a combination of market pull and technological push in order to focus their business on higher-margin services relative to products and, hence, to create superior competitive advantage (Baines and Lightfoot 2013; Breitbach and Maglio 2016). Similarly to the manufacturing industry, the music industry, like other creative industries, had to transition its offerings from selling music in product format to a broader offering of products and services, largely because of the impact of digitalization and the Internet (Parry et al. 2014).

Studies show that information and communication technologies (ICT) facilitate servitization (Eloranta and Turunen 2016; Story et al. 2016). For example, ICTs such as video-conferencing, email, the Internet and social media play important roles in enabling service interactions. Breitbach and Maglio (2016) suggest that process-oriented services such as the online meals delivery services provided by Foodora use unstructured and interdependent interactions between actors. Meanwhile, output-oriented services such as the TotalCare services from Rolls-Royce use more structured and independent interactions.

The commercial benefit of offering services is well documented, where the associated revenue could be five or more times the product-related revenue, and profit margins are potentially up to three times higher for services compared to products (Baines and Lightfoot 2013; Wise and Baumgartner 1999). However, superior returns for servitization among larger firms are not universal, as the higher costs from the provision of services might not be fully compensated in terms of

higher margins (Neely 2008; Li et al. 2015). Moreover, recent studies have shown that servitization might result in short-term performance sacrifices for longer-term performance benefits (Visnjic et al. 2016).

Product firms might offer services for various reasons (Cusumano et al. 2015). On the one hand, there is the provision of services in mature industries, where the product becomes a commodity and, hence, the provision of services provides a means of differentiation and a source of diversified revenues. On the other hand, the provision of services such as leasing is necessary to persuade customers to buy products that are new to the market based on unknown technologies. Therefore, in this case the service comes first and, hence, substitutes product sales. Some scholars have articulated that servitization is a continuum from basic product-oriented services toward more customized, process-oriented services and ultimately to the provision of solutions (Oliva and Kallenberg 2003; Tukker 2004). In such a continuum of servitization, the customer and supplier interface increases from being merely transaction-focused to having more of a relationship orientation, with deep co-engagement from design and development to end-use (Martinez et al. 2010; Gaiardelli et al. 2014; Eloranta and Turunen 2016).

One of the key challenges for firms is managing the transition to services. The existing servitization literature has largely discussed the factors associated with the transition, including enablers and challenges, but has not explored the journey that firms undertake in order to servitize (Martinez et al. 2010; Ng et al. 2013). This is surprising given the vast amount of literature on how many product-based industrial firms still struggle to provide services effectively (Bintner et al. 2008; Reinartz and Ulaga 2008; Neely 2008; Spring and Araujo 2009). In particular, the service literature has been relatively silent on the service change journey that firms undertake as part of the servitization strategy. Various authors have highlighted the limited attention that has been paid to the process of servitization and, in particular, how such change occurs (Bowen and Schneider 2014; Kindström and Kowalkowski 2014; Baines et al. 2016). We explore how the change journey in servitization unfolds within the context of process-based change models (see Van de Ven and Poole 1995; Van de Ven and Sun 2011).

This paper investigates a basic and still relatively unknown enquiry—“What does a service journey look like?” Three case studies, in which three firms have been in transition to supplement their products with services, are discussed in this paper. They describe the service innovations and the transition journeys in the context of complex services. The paper offers four contributions. First, this study demonstrates that servitization follows a continuous change rather than a punctuated equilibrium. It further shows that this continuous change is emergent and intuitive in nature. Second, the study provides empirical evidence to support a contingency view of the dominance and sequencing of the different process models of change across the change journey. Third, this research shows the pace of service development and when the coexistence of basic, intermediate and complex services develops. Fourth, it contributes to the literature in the service field by presenting three actual service journeys and the associated seven stages of the service strategy model that firms need to consider in order to increase the success of their servitization strategy.

### *17.1.1 Theoretical Background*

Servitization has been a growing trend for manufacturing firms (Story et al. 2016; Visnjic et al. 2016). The provision of services can vary for product-based firms. These services could be product-related, such as repair and maintenance. In addition, there are services that support customer use of the products, such as financing, training and optimal use of the product. In doing so, product-oriented firms have increasingly shifted their focus from selling products to solutions that focus on positive outcomes for the customer (Roy et al. 2009; Ng et al. 2013). Studies have classified different types of service in relation to products, namely smoothing, adapting and substituting services (Cusumano et al. 2015). Smoothing services include services that help smooth product sales without altering the underlying product functionality. This includes financing and warranty services. Adapting services are services that expand the functionality of the product or assist customers in using the product in new ways. This could include customization of the product or bundling of the product with other products to provide a bundled proposition. Substituting services are services that replace the purchase of the product for the customer (Paiola et al. 2013; Settanni et al. 2014.). These include services such as "pay-per-use", where the customer substitutes buying the product with paying for the service based on usage. Such a conceptualization of services can also be seen through the lens of "value-in-exchange", where the focus is on exchange between parties, or "value-in-use", where the focus is on consuming the service to solve problems and, hence, achieve the desired outcome for the customer (Vargo and Lusch 2007; Neely 2008; Gaiardelli et al. 2014). Recent studies have questioned the product–service continuum—moving from basic product-oriented services toward more customized, process-oriented ones, and ultimately leading to the provision of solutions (see Kindström and Kowalkowski 2015). The authors argue against the conceptualization of service transition on a uni-dimensional scale across the product–service continuum. They argue that firms must constantly manage the balance between the expansion of customized services to gain differentiation and standardization of the previously customized services into products that are scalable for provision to a larger customer base. Therefore, rather than following an incremental transition process across the product–service continuum, the challenge of servitization for firms is to balance the co-existence of different roles of the service-related business models on a continuous basis.

#### 17.1.1.1 Drivers of Servitization

Studies have suggested three main motivations or drivers of servitization: competitive motivations, demand-based motivations and economic motivations (Baines et al. 2009; Wise and Baumgartner 1999; Oliva and Kallenberg 2003). Competitive motivations are primarily driven by the need to differentiate the tangible product offering, which might be commoditized through service offerings. Demand-based

motivations are primarily driven by customers wanting to undertake certain activities themselves or outsourcing some non-core activities to reap the benefits of scale economies from their suppliers. This implies that manufacturers might need to provide such additional services to support the activities of their customers. Economic motivations are primarily driven by the need to find a new sustainable source of revenue in order to overcome stagnating growth of the product market, to leverage the often more profitable service market and to provide a more stable revenue stream by hedging against the peaks and troughs of product sales. These motivations could be either defensive, in order to help reduce costs for customers and to lock out competitors, or offensive, in order to encourage growth for the relevant stakeholders (Baines et al. 2016). In a recent paper, Raddats et al. (2016) developed a deeper understanding of these motivations for servitization by examining how they are influenced by the complexity of the product offering. The study shows that competitive motivations for servitization appear to be most relevant for suppliers of non-complex products, while economic motivations are relevant for suppliers of complex product–service systems. Moreover, demand-based motivations are relevant for manufacturers across the product complexity spectrum, with an emphasis on cost savings and improving service quality, especially when activities are outsourced.

Service-driven transformation requires the reconfiguration of fundamental elements of the product–service offering, a new proposition development process, sales and delivery process and the value network. Such a process of servitization requires reactivating—altering the set of activities; relinking—altering the linkages between activities; repartitioning—altering the boundaries of the focal firm; or relocating—altering the location in which activities are performed (Dos Santos et al. 2015). Studies have shown that enabling such service-oriented transformation to occur might require different organizational forms and even different organizational structures (Biege et al. 2012). This includes moving from a functional form to a matrix structure to enable better-coordinated change, or having a separate dedicated unit to implement the new service proposition (Rasmussen and Foss 2015). Moreover, new performance-measurement systems are required to support the new service orientation and enable the change initiative while managing incentive-based conflicts among employees (Ng et al. 2011). The transition to services requires a shift in management perspective (Barnett et al. 2013; Alvarez et al. 2015). Therefore, organizations need to change in order for servitization to take hold.

The process toward the servitization of manufacturing is described as a transitional one (Oliva and Kallenberg 2003; Vendrell-Herrero et al. 2014). The steps involved in the transition to service identified in the literature fall into two broad groups. The first is related to the strategic level of the transition to services and the second to the operational level. Table 17.1 summarizes these steps.

Twenty-one steps are identified at the strategic level and seven at the operational level. The majority of these steps are vaguely defined in the literature, and highly independent and discontinuous (non-sequential) from one another, as they have naturally emerged from various disconnected studies. Lim et al. (2012) and Bakås et al. (2013) attempted to provide some sequential steps, but they are still very

**Table 17.1** Steps in the transition to services from the literature

| Steps/Reference | Quinn et al. (1990) | Mont (2002) | Oliva and Kallenberg (2003) | Davies (2004) | Malleret (2006) | Gebauer et al. (2006) | Auguste et al. (2006) | Maglio and Akaka (2008) | Bolton et al. (2007) |
|---|---|---|---|---|---|---|---|---|---|
| Strategic steps | | | | | | | | | |
| Start with product-related services and then extend service offering | | | ✓ | ✓ | | ✓ | | | |
| Establish a service culture | | | | | | ✓ | | | |
| Formation of a separate in-house service organization, decentralization | | ✓ | ✓ | | | ✓ | | | |
| Build relationships with customers, relationship marketing, manage customer perceptions | | | | | | ✓ | | | ✓ |
| Customer involvement | | ✓ | | | | | | | |
| Clear service strategy: appropriate organizational arrangements and resource allocations | | ✓ | | | | ✓ | ✓ | | |
| Identify few core service activities | ✓ | | | | | | | | |
| Coordinate many independent suppliers | ✓ | | | | | | | | |
| Identify market needs | | | | | | ✓ | | | |
| Define | | | | | | | | | |
| Locate | | | | | | | | | |
| Prepare/Identification of potential service-products to offer | | | ✓ | | | | | | |
| Steps/Reference | Quinn et al. (1990) | Mont (2002) | Oliva and Kallenberg (2003) | Davies (2004) | Malleret (2006) | Gebauer et al. (2006) | Auguste et al. (2006) | Maglio and Akaka (2008) | Bolton et al. (2007) |
| Confirm/Selection of services/Design/Service concept + pilot study | | | | | | ✓ | | | |
| Execute/Develop offerings, implementation plan, test with customers | | | | | | | | | |
| Monitor/Evaluate | | | | | | | | | |
| Resolve | | | | | | | | | |
| Modify/Refine/Post-processing | | | | | | | | | |
| Conclude | | | | | | | | | |
| Mapping of existing offerings and resources | | | | | | | | | |
| SWOT analysis | | | | | | | | | |
| Gap analysis with offering orientation and customer interaction | | | | | | | | | |
| Operational steps | | | | | | | | | |
| Employees as operant resources | | ✓ | | | | | | ✓ | ✓ |
| Performance management and measures | | ✓ | | | | | ✓ | | |
| Facilities located in close proximity to customers | | | | | | | | | |
| Planning for service recovery | | | | | | | | | ✓ |
| Information management and communication technologies support | | ✓ | | | | | | | |
| Steps/Reference | Quinn et al. (1990) | Mont (2002) | Oliva and Kallenberg (2003) | Davies (2004) | Malleret (2006) | Gebauer et al. (2006) | Auguste et al. (2006) | Maglio and Akaka (2008) | Bolton et al. (2007) |
| Determine type of HR management required to deliver good services | | | | | ✓ | | | | |
| Involvement of all areas of the company in the development process | | | | | | ✓ | | | |

| Neely (2008) | Kindström (2010) | Baines et al. (2010) | Martinez et al. (2010) | Baines et al. (2011) | Salonen (2011) | Lim et al. (2012) | Smith (2012) | Paiola et al. (2013) | Baines et al. (2013) | Marques et al. (2013) | Bakås et al. (2013) | Barnett et al. (2013) | Baines et al. (2014) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Neely (2008) | Kindström (2010) | Baines et al. (2010) | Martinez et al. (2010) | Baines et al. (2011) | Salonen (2011) | Lim et al. (2012) | Smith (2012) | Paiola et al. (2013) | Baines et al. (2013) | Marques et al. (2013) | Bakås et al. (2013) | Barnett et al. (2013) | Baines et al. (2014) |
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| | | | | | | | | | | | | | ✓ |
| Neely (2008) | Kindström (2010) | Baines et al. (2010) | Martinez et al. (2010) | Baines et al. (2011) | Salonen (2011) | Lim et al. (2012) | Smith (2012) | Paiola et al. (2013) | Baines et al. (2013) | Marques et al. (2013) | Bakås et al. (2013) | Barnett et al. (2013) | Baines et al. (2014) |
| | | | | | | | | | | | | | |
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general and closer to the definition of a typical project management process (see Table 17.1).

The four steps most frequently discussed at the strategic level are as follows: (1) start with product-related services and then extend the service offering; (2) establish a service culture; (3) prepare and identify the potential service–products that will be on offer; and (4) confirm and select the service design or service concept and pilot study (Oliva and Kallenberg 2003; Davies 2004; Gebauer et al. 2006; Neely 2008; Kindström 2010; Martinez et al. 2010; Salonen 2011; Lim et al. 2012; Barnett et al. 2013; Marques et al. 2013; Bakås et al. 2013).

The two most frequent operational steps are as follows: (1) establishing the employees as operant resources; in other words, these are the service-related knowledge and skills of employees; and (2) implementation of performance management and measures for the service business (Mont 2002; Auguste et al. 2006; Maglio and Akaka 2008; Bolton et al. 2007; Martinez et al. 2010; Baines et al. 2011, 2013, 2014).

In addition, a small body of literature discusses the point of destination of the transition to services. Particular attention is paid to the "visualization of the intangible value of service offerings, the definition of value for the customer, and how value creation and delivery would take place" (Kindström 2010; Salonen 2011; Smith, 2014; Bakås et al. 2013: Smith et al. 2014).

#### 17.1.1.2 Business Transformation and Organizational Change

Servitization is a form of business transformation that calls for organizational change (Vendrell-Herrero et al. 2014). The transition to services across the spectrum of services might require different approaches to managing change. On the one hand, studies have shown that service provision needs to be planned with incremental changes as the firm moves through the different phases of servitization (see Oliva and Kallenberg 2003; Tukker 2004). On the other hand, studies have shown that a more adaptive approach is needed, as the servitization journey requires increasing engagement between the customer and the service provider, which entails a process of experimentation and learning (Martinez et al. 2010). However, recent studies have argued that such an incremental or adaptive approach might not be optimal, whereby there is a need to provide complex services where the outcome is emergent and unknown from the outset. In such a case change is required across all stakeholders covering strategy, organization, enterprise management, contracting, culture and operations management (Barnett et al. 2013). Therefore, a more holistic, system-wide change is required across the value chain, network of relationships and performance-management systems in order to affect the servitization strategy successfully (Fang et al. 2008; Gebauer et al. 2010). Such a transition demands a new mindset driven by cognitive reframing that should pervade the entire firm, its network and the ecosystem in which it operates (Gebauer 2008; Visnjic and Val Looy 2013; Ng et al. 2013).

At a broad theoretical level, organizational change management has been dominated by two approaches: first, there is the punctuated equilibrium model, which assumes that long periods of small, incremental change are interrupted by brief periods of discontinuous, radical change (Tushman and Anderson 1986; Gersick 1994). Alternatively, the theory of continuous change suggests that change is not episodic but endemic to the way in which organizations operate, with the ability to engage in rapid and relentless continuous change, which is "a crucial capability for survival" (Brown and Eisenhardt 1997; Langley et al. 2013).

Additionally, scholars have highlighted different typologies of organizational change process. For example, Van de Ven and Poole (1995) and Van de Ven and Sun (2011) identified four process models of organizational change: teleology (planned change), dialectics (conflictive change), life cycle (regulatory change) and evolution (competitive change). Other scholars have proposed helpful variations of these four basic models of organizational change (see Huy 2001; Weick and Quinn 1999). A teleological process involves planned change based on a group of participants agreeing and moving to achieve a shared organizational goal. A dialectical process involves different organizational units facing conflict and confronting one another on such conflicting issues. The life-cycle process involves recurrent and predictable organizational change in a regulated manner. Finally, the evolution process involves multiple units within or between organizations competing for scarce resources. These process models differ in terms of whether they apply to single or multiple organizational entities and whether the change process follows a prescribed sequence or is constructed (emerges) as the process unfolds. Each theory views the process of development as unfolding in a fundamentally different progression of change events and being governed by a different generative mechanism or "motor". These four models of change can be seen as alternative perspectives on a single phenomenon or as different phases of change across time.

Such change processes may unfold over a number of phases of emergence, development, implementation and diffusion (Hargrave and Van de Ven 2006). The emergence phase involves actors constructing a new envisioned state, but before mobilizing plans and resources. The development phase is where different networks of organizational actors propose their competing claims for alternative proposals for organizational change. This is followed by implementation and diffusion once a particular vision has won the political campaign and becomes legitimized. The four process models of change could play a dominant role in each phase of the change process. This requires management to take action and also to reflect on that action in order to adjust their model to fit the process of change unfolding within an organization. However, the empirical evidence about how such an organizational change journey unfolds, and its implications for the corresponding process theory of change, have received little attention. Our study aims to explore which of the two schools of thought concerning change are most relevant to servitization.

### 17.1.2 Method

Three independent service journeys were studied in order to understand the service journey from the very beginning to the present. Three criteria were used to select our cases: the influence of technology on the firms' servitization; the maturity of the firms' transition to services; and the servitization contexts.

Tongur and Engwall (2014), Baines et al. (2016) and Breitbach and Maglio (2016) have highlighted the need for further research into "the influence of technology on servitization". The three cases were primarily selected on the basis of the role and influence of technology (such as digital technology, IoT and data analytics) on the service offering(s) and service business model(s). These three cases are an animal well-being firm, a process engineering firm and a learning provider firm. The three cases range from having intermediate to advanced influence of technology.

Next, to enable a fair comparison of the different service journeys, we further selected cases with a similar kind of "maturity in the transition to services". All selected cases actively began their servitization journeys 7 years ago.

Finally, a complementary selection criterion was the "servitization context". Parry et al. (2014) suggested the extensive learning benefits of studying contexts that are distant from manufacturing ones, such as music and creative industries, in understanding the servitization phenomena. Thus, we diversified our case selection and selected a typical mainstream case, "the engineering case", and two other contexts that go well beyond manufacturing—"the well-being case and learning case".

The service journey is our unit of analysis. A qualitative research strategy, supported by interviews and focus groups, is an appropriate method with which to study the service journey comprehensively (Edmondson and McManus 2007).

Fifty-two interviewees participated in this study. In order to build a complete and objective understanding of the service journey, we interviewed the president, vice presidents, directors, managers, technology developers, service coordinators and customer-facing employees. The interviews were guided by a structured questionnaire, documented in our research protocol. The interviews yielded 3390 min and 1062 pages of transcripts.

The interview transcripts were analyzed using content analysis, coding and pattern identification. Finally, a descriptive analysis of each journey fed the cross-case comparisons. The cross-case analysis colour-coded the individual journeys, highlighting the journeys' intersections.

Twenty-eight initial steps explain the service journey. Then, eight more steps were added through a "feedback-focused group" with ten senior managers. In total, 36 steps in the service journey were identified. We analyzed and clustered them into 12 themes, which became the "stages" and "steps" of the service journey.

The 12 stages of the service journey evolved and created the service strategy model, based on the feedback from "two validation-focus groups"—the first in July (with 22 participants) and the second in September (with 12 participants).

**Table 17.2** Firms' backgrounds

| | Firms | | |
|---|---|---|---|
| | Well-being | Engineering | Learning |
| Principal business | Development and manufacturing of animal health and well-being medicines, diagnostics and genetics | Process technology and components for sophisticated production processes | Education, consumer publishing and business information |
| Business model | Upstream | Upstream | Moving downstream |
| Current core competencies | R&D, manufacturing of bio-pharmaceutical products and direct selling model | Development and installation of process technology | Development of learners' assessments and certification |
| Customer focus | Mainly on companion animal and livestock veterinarians and livestock producers. Moving to pet owners | On product specification and technology to support customers' processes | On education and learning services for academic institutions |

### *17.1.3 Firms' Background*

The participating firms in this research are three global product leaders—an animal well-being firm, a process engineering firm and a learning provider firm. Their annual sales are similar, with 5500 million US dollars being the average sale per annum per firm (with a variation of ±6.5%).

Traditionally, the reputation and brand image of these firms comes from the successful positioning of their products in their respective markets. All three operate in completely different environments, and yet they share a common strategic goal—"competing on services". Historically, their business models have been developed upstream, with strong resonance in product development and manufacturing, as observed in Table 17.2.

To date, despite their upstream business models and their product-oriented core competencies, they have all been infusing services into their strategies and operations. They all are moving away from basic services such as spares, repairs and reactive maintenance, to more complex (customized) services. In this paper, when we refer to services, we mean complex services.

### *17.1.4 Firms Service Journeys*

The progression of a firm's journey in the adoption of services is the main line of enquiry. The description of the progression of facts and steps seeks to emphasize the experience and authenticity of these journeys.

A complete story of these journeys cannot commence without analysis of the triggers that motivated the change. In other words, what caused these firms to

embark on the exploration of services? Therefore, this section begins with an analysis of the logic behind shifting to services and then moves to the analyses of individual service journeys. The next section discusses the findings from the cross-case analysis. Throughout this paper, these journeys are referred to as the well-being, engineering and learning service journeys.

#### 17.1.4.1 Logic to Embark on the Journey to Services

The journeys all began around 7 years ago, when these firms observed a progressive change in their customers' consumption patterns and the surrounding environments.

"...Students are buying less printed books... Shift to on-line digital markets... The economics of the Internet distribution", were some of the triggers that a vice president of the learning firm highlighted for the shift to services. These triggers have consequently driven a steady decrease in the sales of printed books. The rationale behind this firm adopting services was to "increase new sources of revenue generation".

In the well-being firm, a vice president commented: "We've got a heavy research and development base... big investments in discovering new treatments... product to market is 5 to 10 years. This model does not generate new customers... but creates deeper penetration on existing ones.... For us, product innovation is beginning to slow down, it's becoming extremely expensive." A senior manager of services added: "...what happens next is ... this new area of innovation is now around digital, services and differentiation." For this firm, according to an executive vice president, the rationale behind services was to "increase customers' loyalty and add more value to customers than competitors through continuous and progressive differentiation".

The vice president of services of the engineering firm emphasized that, "... traditionally, our services were defined as the supply and the installation of spare parts, end of story... this was a protected area because it was very profitable, but not fully exploited!" The firm's rationale for adopting services was: "We know that services will be the differentiating factor if a customer is going to continue to do business with us or possibly will change supplier."

All three firms recognized the increasing difficulty inherent in retaining their leadership and differentiating from their competitors by competing based solely on products. They equally agreed that in order to remain competitive, they would need to innovate their existing customer offerings. They have therefore embarked on a journey to explore different service strategies to diversify their portfolios.

For the last 7 years, these firms have been actively exploring and implementing services. They are innovating their service portfolios by creating a diversity of services ranging from basic to complex. In the next 5–10 years, the learning firm expects "services" to be the main revenue generator. On the other hand, the well-being and engineering firms expect "services" to contribute to their total value propositions and to de-risk their competitive positions.

#### 17.1.4.2 Well-Being Service Journey

Hence, this journey began by “creating the vision for selling services and solutions” and then “positioning this vision as a global vision”. This was followed by “getting leadership support to take risks and make investments” for the exploration of services.

At this point in the journey, it was difficult to gain support from board members to set and deploy resources “in a decentralized way”. However, this proved to be a crucial element, as “it shows the entrepreneurial approach and commitment of the firm to grow services”, as emphasized by a senior director of service development. Furthermore, it was followed by “appointing the exploration team with resources and time”.

In this journey, agreeing the framework for the exploration and development of services took a tremendous amount of coordination between the two service-leading regions—North America and Europe. The paradigm shifted to “evolve from features to customers’ needs and the impact on service selling training”, “identifying the opportunity gap: customer needs vs demands” and “explore: starting from the places closest to customers”. The journey then proceeded to “rolling out these changes to all functions and getting active participants from the top”.

Instead of progressing toward consolidation of the foundations of the service-operating model, this journey retroceded to the early steps to the “assessment of existing resources and gaps”. Then, it proceeded to “define the service innovation approach” and “the acquisition of new capabilities”. A business solution manager added “. . . returning to the early steps is frustrating. . . takes concentration away from the progression on services and extends the duration of the journey. . . but we learn things that initially we overlooked...”

The journey moved forward to establish a delivery model by “developing and managing service contracts” and “learning to price new services”. It also “establishes the discipline to process, go, define, deliver and validate services”. Service design is centralized and largely entrepreneurial. Over the years, this firm has developed and launched more than twenty services with various levels of complexity and purposes. Over the last 3 years, the firm has been aggressively trying to move toward the experimentation of complex services for B2B and B2C. Part of this firm’s journey is about managing the partnership to complement its existing service skills. As more services are piloted and tested, the journey takes steps back to the initial discussion about the reallocation of “funding: unit vs central”.

Services have been launched predominantly in the US and Europe. As the portfolio of services has grown in both parts of the Atlantic, there has been an evolution in the selection of services in which to invest and to launch on the market. An early “. . .framework of criteria to select services with the strongest potential to be commercialized” was introduced, which brings structure and formalizes the service-selection process.

Currently, the journey is moving toward a more mature phase, where different ways to optimize service innovation, commercialization and delivery are taking

place. For instance "…optimize… the way to regionalize… get higher quality lower cost-price… keep the modeling & analysis for the optimization of services".

#### 17.1.4.3 Engineering Service Journey

The strong legacy of product innovation and large business fragmentation has made it difficult for this journey to take off. As the head of service delivery explained: "… grown by mergers and acquisition has massive implications… some business segments are more mature in selling services than others, offer different types of services and have different ways to deliver them…" According to a vice president, this journey therefore started from the very basics in order to "… get a common definition of services and solutions' selling across the firm". Soon, the firm moved to "… define services as part of the corporate strategy" and then to "... create vision for solutions' selling", the director of services explained.

The journey continued by "… appointing the leading exploration team [across and within segments]" and then proceeded to "… get resources closer to the vision", as described by a segment president. While there is evidence of investments and resource allocation for the design and exploration of services, they have generally come from individual segments as opposed to a central account. This means that individual segments are accountable for the success or failure of services, but are still rewarded according to overall revenue generation, where services often contribute a minimal amount. Therefore, segments consciously limit the exploration of services.

The firm tried to "…open, share and harmonize information [across segments and functions]", as the service manager explained. The lack of a common information system—there are several as a result of numerous mergers and acquisitions—makes this journey more challenging.

In moving forward, the firm has focused on "…designing the service delivery and service selling strategy" and "… defining the service approach to innovate", explained a segment president. Traditionally, service design is incremental, but it is gradually moving beyond the basic services. The exploration and launch of services are decentralized and ad hoc. Recent structural reorganizations have centralized the strategy and management of services, which benefits the growth of the services portfolio and encourages the development of in-house service skills. Currently the firm's journey is focusing on "… establishing a discipline to process, go, define, deliver and validate services", and "…monitoring and communicate results", added the director of services

#### 17.1.4.4 Learning Service Journey

For more than a decade, top leaders have had numerous isolated discussions about selling services in the education sphere. However, altogether this actively began around 7 years ago, as the vice president of strategy explained: "…. when we realize that our traditional businesses are coming under pressure and at the same time clients

are asking us for services that we didn't offer or had in our catalogue, this creates an enormous pressure that made us wake up and react." Building on this, the firm took the opportunity, first, to "...establish the sense of urgency of the situation" across all divisions and, second, to "create a long-term business case", as the head of service delivery explained. It was then that the firm began to "create general awareness to make the shift to services". To get the message across the entire firm, it used the analogy of the bankruptcy of Kodak's instant camera and its inability to react to the market and technology revolutions. The analogy made people more receptive to welcoming services.

"The development of the responsible head for the service business model and testing" was the next step in formalizing the initial infusion of services in the firm, as the director of business transformation explained. This was followed by "...understanding own firm resources – soft skills, behaviors and culture – processes, requirements and gaps", the vice president of service solutions added. Subsequently, the firm began to "... exploit, explore and experiment...". It was then that "... we roll[ed] out the change to all functions and get active participants from the top", the director of leadership explained.

This journey took a step back to learn lessons about how, and to what extent, to "... co-develop services with customers". It then moved forward by proactively "seeking new [services] opportunities – analyzing service data and looking for opportunities to make a positive impact [on customers' business performance]", explained the director of business transformation. During the journey, the firm became trapped in a cyclical phase of co-development and active identification of new services that overlooked the overall management of these new services, such as cost-benefit, correct pricing, and so on. For instance, among tensions arising in this service journey were funding policies, length of service incubation and evaluation mechanisms to terminate unprofitable services, for example. Service design grows organically through enthusiastic groups of employees on key selected institutional customer businesses. The firm is building a wide portfolio of services, from product-based to results-oriented services, using efficacy measures to demonstrate the value of the services to customers and end-users. For a long time, the management of service design and development has been unstructured, but over the last 3 years strong emphasis has been placed on the strategic management of service development. A large part of this journey has been focused on the development of service skills. The firm develops its service skills through a combination of acquisitions and in-house learning.

After a while, the journey moved to "... building up people's jobs: services' targets, key performance indicators (KPI) and individual KPI", explained the head of delivery. The president of integrated solutions added: "We eventually learnt that ...top management has to be very involved. They need to manage and run the business, which are two different things." Then the journey moved to more proactive steps—it "... encourages the use of the new business model and good practices [on a daily basis]", highlighted the vice president of emergent models.

The longest part of this firm's journey, explained the director of business transformations, has been to "... change people's minds to services"; "... trying to build

up services internally and organically, in a company that is primarily a product-based company is a very difficult step... different people's mindsets and not all of them understand that services are not products and need to be treated different", added the president of integrated solutions. "Since our new CEO took over around three years ago, there is stronger support and focus on services", added the vice president of service solutions. Currently the firm is focused on improving service governance—standard service processes designed to speed up the cycles, from service design and incubation to the point of sustainable commercialization.

#### 17.1.4.5 Service Development in Transition: The Pace of Change

The evolution of the development of services of the three cases over 7 years is illustrated in Table 17.3. A number of common themes or trends cutting across the three different cases were observed.

An early trend at the beginning of the service journey, during the first 3 years of the firms' transition to services, was to build up basic services and then move carefully and incrementally out from the basic services, adding a few intermediate services. These intermediate services are user-oriented services, with only a small degree of customization (see Baines and Lightfoot 2013). This early incremental transition is aligned with previous studies around the servitization continuum of service offerings (see Oliva and Kallenberg 2003; Tukker 2004; Gebauer 2008).

After the fourth year in the transition to services, something interesting took place across the three cases. We observed that the pace of change evolved from the

**Table 17.3** Service development over time

| | Firms | | |
|---|---|---|---|
| Time | Well-being | Engineering | Learning |
| 1–3 years | Basic services close to the product, such as certification of vaccination, diagnostic services | Basic services such as installations, spares and repairs | Basic service supporting products, such as maths lab software |
| 4–7 years | 1. Continue with intermediate services, such as consultancy and performance indexes. ICTs enable the service interactions<br>2. Explore more customized services, such as real-time health check and advice services powered by apps. ICTs are an integral part of these customized services | 1. Continue with intermediate services, such as training, condition-based monitoring and predictive maintenance. ICTs enable the service interactions<br>2. Explore more customized services, such as total plan management (in pilot) and proactive maintenance. ICTs enable the service interactions | 1. Continue with intermediate services, such as diagnostic assessments and benchmark assessments. ICTs enable the service interactions<br>2. Explore more customized services, such as online tutoring and mentoring solution outcomes measured by the service efficacy. ICTs are an integral part of these customized services |

"incremental development of services from basic to intermediate" to "two concurrent streams of service development".

1. The first stream kept the incremental peace of service development by building on the current intermediate services.
2. The second stream accelerated the service development by exploring and adding more complex (highly customized) services to already existing service portfolios.

This pace of change shown in this longitudinal analysis of the service is not fully explained by the previous literature. Our research is consistent, to a certain extent, with the previous research on the incremental continuum of service development (Oliva and Kallenberg 2003; Tukker 2004; Gebauer 2008), radical services (Loving 2011; Smith 2013) and the co-existence of different types of service across the service continuum (Kindström and Kowalkowski 2015), but it argues that these changes occur at different points in time during the service journey.

### 17.1.5 Findings Through a Cross-Case Comparison

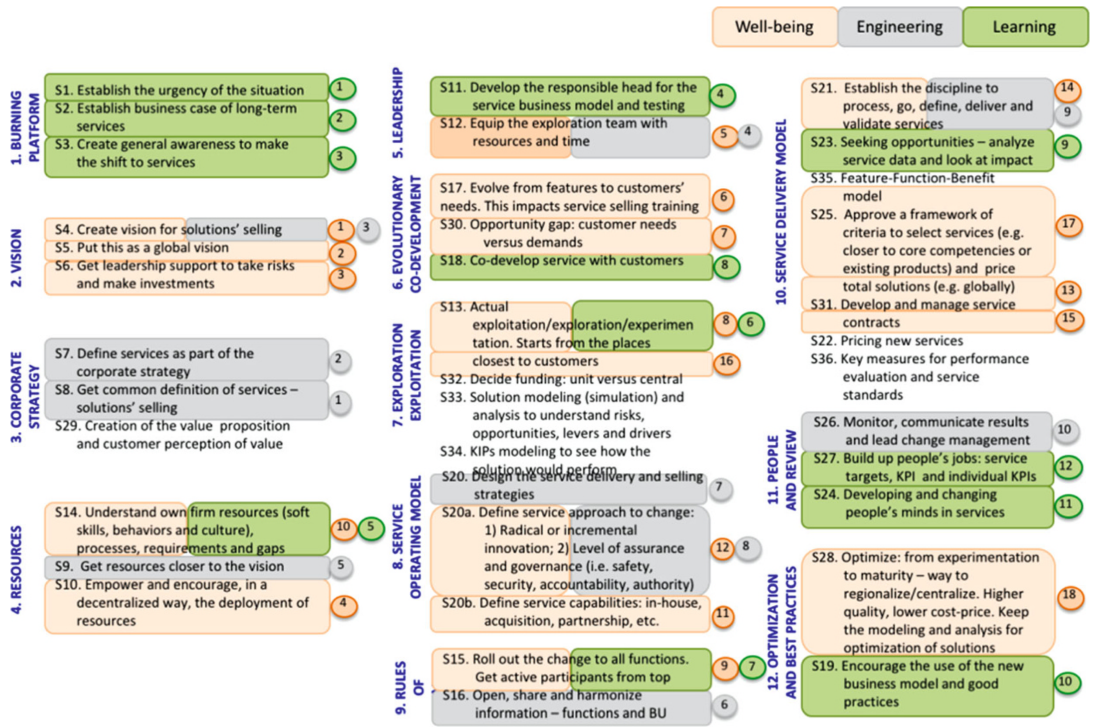
In total 36 steps in the service journey were identified. Twenty-eight initial steps emerged from the interviews and eight more were added from the first feedback focus group. We analyzed and clustered the 36 steps into 12 themes, which became the stages and steps of the service journey.

The firms' service journeys are illustrated in Fig. 17.1. The journeys are colour-coded and the chronological steps of each journey are indicated on the right-hand side of the steps.

All three service journeys have different starting points. The learning journey began by creating a burning platform to attract the firm's attention to services. The well-being journey began by positioning services within the firm's vision. Finally, the engineering journey began by defining services and positioning them as part of the corporate strategy. Kindström (2010), Salonen (2011), Smith (2014) and Bakås et al. (2013) highlighted the importance of the point of destination in the transition to services, particularly the definition of the end value for the customer. Conversely, there is a lack of literature explaining the point of departure in the transition to services. This study shows a variety of points of departure.

The general notion of a single-path journey to services is not supported by our results. On the contrary, the three journeys show three different paths. Oliva and Kallenberg (2003), Tukker (2004) and Gebauer (2008) discussed the incremental continuum of services during the transformation and inferred the idea of a single-path journey on the continuum. The preliminary analysis of our cases shows that there is no single-path journey but largely evolutionary journeys; a deeper cross-case comparison enabled us to make the following observations:

(a) All three firms have shared some common steps during their journeys to services. These steps are localized on four shared stages of the service journey:




***Note:*** *Individual firms' service journeys are colour-coded and the sequences of the journeys' steps are numbered on the right-hand side of the colour-coded activity.*

**Fig. 17.1** The service journey: cross-case comparison

(1) resources, (2) leadership, (3) service delivery model and (4) rules of change (see Fig. 17.1).

(b) After positioning services at the core of the firms' vision and strategy, creating "leadership" and "resources" are the subsequent stages that all three journeys followed. Then, in the later stages of their journeys, all three firms have come back, revisited and improved the initial steps in the "leadership" and "resources" stages. This is achieved once a more mature understanding and experience of services are reached.

(c) The "service delivery model" is the stage of the journey on which greater emphasis has been placed by all three firms.

The chronological order of steps differs from journey to journey. In all three journeys, the back-and-forth sequence of steps is observed. Various interviewees, for example, the innovation director of the well-being firm, described their journeys as "...emergent and organic...". A service manager from the engineering firm added: "... In some occasions, we feel this is a trial and error approach." The theory of continuous change suggests that change is endemic, rapid and relentless (Brown and Eisenhardt 1997; Langley et al. 2013). This theory highlights the importance of understanding the process of change and calls for more research in order to understand change at a micro-level (Van de Ven and Sun 2011). Parallel to this, the servitization literature calls for a deeper and clearer explanation of how the transition to services is made (Baines et al. 2016). The chronological order, and the back-and-forth sequence of steps shown in this study, explain the micro-processes of how incremental change processes unfold. This is the first study in the transition to services to demonstrate the micro-process of how change unfolds.

The "co-development" and "exploration" stages are important in designing services (Meyer-Glodsmith et al. 2002; Maglio and Akaka 2008). The well-being and learning firms have incorporated these stages in their service journeys by trying to establish some early guidelines and processes to co-develop, explore and exploit services. The initial guidelines and processes were incomplete. As time has passed, these early guidelines and processes have evolved and improved. Other studies have highlighted the importance of experimentation and learning as key capabilities in the organizational transition to services (Martinez et al. 2010).

From the learning perspective, it was observed in each particular case that every launch of a new service was vaguely informed by previous experiences and therefore treated as a new project. Across the three journeys, there has been a general tendency not to document the lessons learnt from successes and failures. Recently, the well-being journey has begun to document the decisions and actions of the service design and delivery as part of its normal routine. Starbuck and Hedberg (2015) highlighted the importance of building up organizational learning, particularly in times of change. They argued that learning arises from automatic reactions to performance feedback, and learning from successes is as important as learning from failures. Our three firms eventually began building up their learning about the transition to services in an emergent and unplanned manner. The well-being and learning firms are building it up faster than the engineering firm.

The feedback focus group provided an opportunity for participants to analyze retrospectively their service journeys up to this point, to question the decisions and chronological steps and to enhance their learning. A technology developer from the well-being firm commented, ". . . now, I can see why it did not work out the first time around. . . it took us too much time". ". . . I can clearly see the steps and where to go. . . it is simple... but before we did not have this clarity...", the vice president of service solutions from the learning firm added.

Discussions about the service journey findings evolved from the "it is" status to the "should be" status. In other words, after learning about these three service journeys, the next logical question that people asked was: "What are the critical elements that should be present in any service journey to ensure a smooth transition to services?"

To answer this question, there were two additional focus groups (22 and 12 participants correspondingly). All participants were actively working in service-transitioning firms. The first focus group built the service strategy model from the steps of the service journey and the second focus group validated the service strategy model.

In the first focus group the 12 stages of the service journey (including their corresponding steps) were taken apart and then brought together again to find a logical sequence (seven prototypes of this logic were created until everyone agreed on the most comprehensive and coherent one). Then, each stage was analyzed, some steps were moved from one stage to another, some stages were renamed, others were merged and a new one emerged. For instance, the "burning platform" stage of the journey evolved and became the "assessment of the market and internal readiness". The "structures and governance" stage was built from the steps from the service journey. In conclusion, the 12 stages of the service journey evolved into seven stages and created the "service strategy model".

In the second focus group, this model was validated with the last focus group of 12 vice presidents, directors and senior managers of five participating firms. The service strategy model has seven validated stages, which are the critical element for the transition to services (see Fig. 17.2). All stages are interdependent and need to operate concurrently to enhance service performance.

### *17.1.6 Discussion*

This study has explored which of the two change management theories are most relevant to servitization: the punctuated equilibrium model (Tushman and Anderson 1986; Gersick 1994) or the continuous change model (Brown and Eisenhardt 1997; Langley et al. 2013). This research observed that service journeys that are studied consistently follow the continuous change model, where change in servitization is not occasional but endemic in the way in which firms typically operate. Furthermore, this continuous change is neither logical nor structured but much more emergent and intuitive.

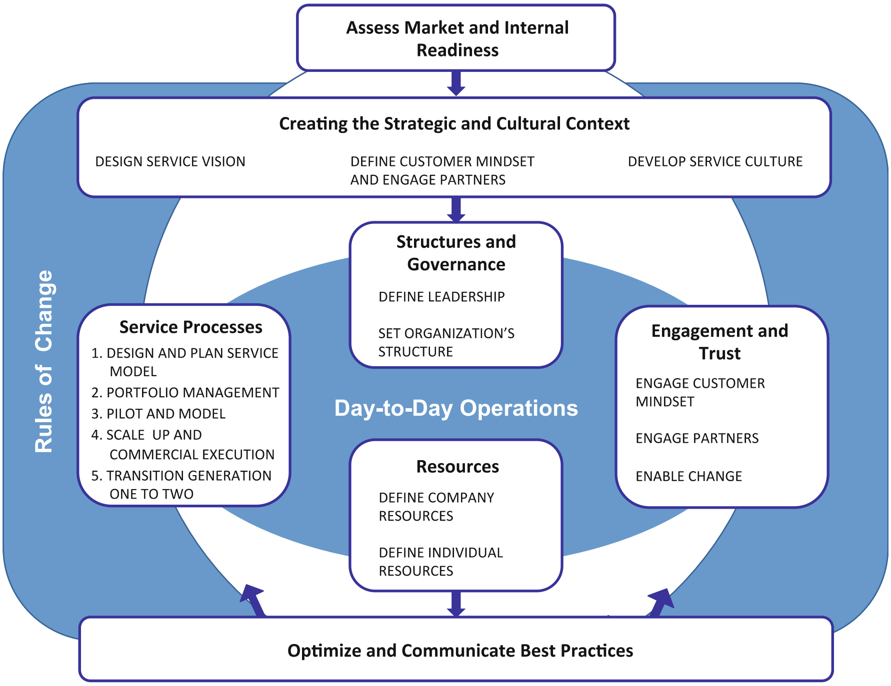



**Fig. 17.2** Service strategy model

The majority of the literature on the service journey reports on studies of challenges and enablers (Mont 2002; Gebauer et al. 2006; Marques et al. 2013; Baines et al. 2014). It seems, however, that there is limited reporting of in-depth longitudinal studies explaining the details of individual firms' step-by-step service journeys (Vendrell-Herrero et al. 2014; Baines et al. 2016). In this study we sought to overcome this shortcoming by explaining in some detail the actual service journeys undertaken by the three firms. We used these experiences to create an illustrative "service journey route map" (Fig. 17.1). In each case, the firm's service journey was evolutionary and emergent. Our retrospective analysis suggests three reasons for this. First, our three case study firms were deeply routed in their traditional products. They displayed technical and organizational excellence in terms of product development and delivery, but had to learn—often through trial and error—about services. Second, the paucity of extant literature and verified frameworks for explaining the service journey meant there was little reference matter available (as also highlighted by Kowalkowski et al. 2013; Kindström and Kowalkowski 2015). Third, our analysis shows that the shift to services involves some elements of evolution or co-evolution. Van de Ven and Sun (2011) supported the idea that evolution is one of the most common process models of organizational change. This change process is either prescribed or constructed (emerges) as the process unfolds. This research shows that firms adapt their business models,

processes and service offerings as their customers' needs and aspirations change in a co-evolutionary way with their closest ecosystem partners. The extant literature on process-change models focuses on the internal dynamics of the change journey by examining the generative mechanism of change, primarily from internal stakeholders' perspectives and conflicts. We extend such a change process to include the wider ecosystem of partners, from customers to suppliers, in contributing to the generative mechanism of change. These cover the four process models of change, including life cycle and evolutionary convergence aspects and teleological and dialectical divergence aspects.

## 17.2 Pace of Change

Previous studies have not fully explained the pace of change in servitization. This longitudinal research shows that during the first 3 years the organizations built up their basic services and then carefully added a few intermediate services to their service portfolios. After the fourth year, two parallel streams of change arose. The first one kept the incremental peace of service development, focusing on basic and intermediate services. The second stream accelerated the service development by exploring and adding more complex (highly customized) services.

To a certain extent, our research agrees with both the incremental continuum of service development from Oliva and Kallenberg (2003), Tukker (2004) and Gebauer (2008) and the radical development of services from Loving (2011) and Smith (2013). Incremental and radical service development co-exist, but only at later stages of the service journey. This research builds on the research of Oliva and Kallenberg (2003), Tukker (2004), Gebauer (2008) and Kindström and Kowalkowski (2015) by providing a clearer explanation of the service development dynamics, particularly the pace of service development (when) and the types of service being developed (what). Our research extends the research of Kindström and Kowalkowski (2015) by further explaining when the coexistence of basic, intermediate and complex services occurs across the service continuum.

## 17.3 Similar Steps, Different Journeys

Three key factors differentiate the journeys of our case study firms—the type of steps, the chronological sequence of these steps and their actual implementation.

First, the type of steps taken in a journey could render the journey explicit and useful or ambiguous and meaningless. For instance, the engineering journey provided less clarity (fewer steps) on the co-development, exploration and service delivery stages. This led to ambiguity, until individual teams determined how to overcome their own problems in terms of exploring and delivering services. The conventional model of change assumes phases of change, from emergence and

development to implementation and diffusion. The literature acknowledges that there might be "back and forth" elements between these stages. However, the literature on such a model is silent on the degree of uncertainty through a process of political bargaining among stakeholders that contributes to the legitimacy of a particular program of change (Hargrave and Van de Ven 2006; Van de Ven and Sun 2011). In contrast, our study shows that such a process of increased clarity might not be the only course of progression; rather, there could be increased ambiguity from the change journey.

Second, the chronological sequence of steps influences the logical evolution of a journey. The logical sequence of steps precludes a journey from forward and backward paths, which consequently impacts the length of the journey. For instance, the learning and well-being journeys have both followed the step called "understand own firm resources, processes, requirements and gaps". The learning journey has followed a natural and logical step of "appointing the service leader" and then "understanding the resources...". On the contrary, the well-being journey has moved forward toward the co-development and exploration of services and then realized that it has to go back to "understand the firm's resources, processes and gaps" before advancing the exploration of services.

Third, the implementation of the steps could make one journey look very different from another. For instance, the well-being and learning journeys have both followed the step called the "exploitation/exploration/experimentation of services". In the case of the well-being firm, as a segment president explained, it implements service exploration and experimentation processes where "… employees are allowed not to always meet expected outcomes… we [all employees] need to learn and improve". On the other hand, the learning firm expected each service experiment to succeed and progress toward the commercialization of services: "… learning from failures is not heavily penalised but not welcome", as the head of direct delivery explained. "The chronological sequence of steps" and "the implementation of steps" have influenced the logical evolution of the engineering, well-being and learning journeys, as explained by the literature on "the phases of change processes" (Van de Ven and Sun 2011). In particular, our study provides empirical evidence to support a contingency view of the dominance of the different process models of change across the change journey. It shows that the dominance and sequencing of planning, conflict, regulation and competition across the change phases are contingent on several factors, such as the role of leadership, the forces of customer preferences, the readiness of the ecosystem partners, as well as the resource availability and allocation processes within firms that are servitizing. In doing so, our study provides a nuanced understanding of the phases of the change process—from emergence and development to implementation and diffusion—in the transition to services. Such in-depth understanding of the change process at the micro-level is important, as it unveils how change actually happens and, hence, contributes to both the theory and practice of critical business transformations such as servitization (Langley et al. 2013; Baines et al. 2016).

## 17.4 Co-existence of Different Types of Service on a Service Journey

Previous research suggests that the capabilities, governance, structures and resources required to offer basic services (Baines and Lightfoot 2013; Biege et al. 2012) or product-based services (Tukker 2004), such as spares and repair services or consulting and training services, do not differ significantly from traditional product-based capabilities and delivery processes. Therefore, it could be inferred that a journey to basic or product-based services would not be a drastic one.

Our research shows that the three firms studied have gradually offered a variety of services, ranging from product-based services to more complex ones. ICTs generally play an important role in enabling service interactions between actors (Breitbach and Maglio 2016; Eloranta and Turunen 2016); however, we observed in our study that in the provision of complex services by the well-being and learning firms, ICTs were an integral part of the service provision.

We observed that, at a certain point during the journeys, a critical and common problem across all three service journeys is constantly having to manage the balance between customized (complex) and standardized services (scaled services). In particular, the well-being and learning journeys have a wide variety of types of service. Our research findings support the assertion of Kindström and Kowalkowski (2015) that an important issue to explore is the co-existence of different types of service and their corresponding business models; however, we would argue that such enquiries also need to take into account the service journey.

## 17.5 Three Complementary and Yet Incomplete Journeys

An interesting question that this study raises is whether the full shift to services requires firms to complete all 12 stages outlined in the service journey route map. None of the firms studied had completed all 12 stages; yet in workshops and discussions they recognized the value of the steps they had missed or not yet begun. Our hypothesis is that for firms starting out on the shift to services, the service journey route map will provide a valuable guide to the transformation they are about to undertake.

### *17.5.1 Conclusions*

All three firms recognized the increasing difficulty of retaining their leadership and differentiating from their competitors by competing based exclusively on products (Cusumano et al. 2015; Eloranta and Turunen 2016). They equally agree that, in order to remain competitive, they need to innovate their existing customer offerings

(Raddats et al. 2016). They have therefore embarked on a journey to explore different service strategies in order to diversify their portfolios.

This paper investigates the basic and yet overlooked question, “What does a service journey look like?” It concludes that service journeys do not follow a single path or even share the same point of departure.

## 17.6 Implications for Theory

The paper offers four contributions. First, in the change literature there are two dominant theories: “The punctuated equilibrium and the continuous models.” This study demonstrates that servitization is much more of a continuous process than a punctuated equilibrium. It also shows that the continuous process is neither logical nor structured but emergent and intuitive in nature. While structure and frameworks might be appealing, these have to be created in a way that recognizes and allows for an emergent servitization journey and provides scope to respond to opportunities and challenges as they arise.

Second, the study provides empirical evidence to support a contingency view of the dominance and sequencing of the different process models of change across the change journey. The chronological sequence of steps shown in this study, including the back-and-forth sequences, contributes to the typologies of organizational change, particularly to the fourth process model, “the evolution process” (Van de Ven and Sun 2011), by explaining at a micro-process level how change unfolds. This is the first study in the transition to services to demonstrate this micro-process of how change unfolds.

The service journey and its 12 stages and corresponding sequential steps contribute to the literature on the transition to service by explaining how incremental change takes place. The previous literature on servitization shows some steps in the transition to services. These are largely independent, discontinuous and sequential from one another (see Mont 2002; Oliva and Kallenberg 2003; Davies 2004, 2007; Gebauer et al. 2006; Neely 2008; Kindström 2010; Martinez et al. 2010; Salonen 2011; Lim et al. 2012; Barnett et al. 2013; Marques et al. 2013; Bakås et al. 2013). This study contributes to the literature in the service field by presenting three actual service journeys.

Third, this longitudinal study on the evolution of service development is not explained by previous research. Our research is consistent, to a certain extent, with previous research on the incremental continuum of service development (Oliva and Kallenberg 2003; Tukker 2004; Gebauer 2008) and the co-existence of different types of service across the service continuum (Kindström and Kowalkowski 2015). Our study extends the research of Kindström and Kowalkowski (2015), Oliva and Kallenberg (2003), Tukker (2004) and Gebauer (2008) by providing a clearer explanation of the dynamics of service development in the long term. In the first 3 years the development of services followed an incremental evolution of basic to intermediate services. In subsequent years the development of services has followed

two concurrent streams of service development—"the continuous evolution of the basic to intermediate services and the emergence of complex services". This study explains how the evolution of services took place in our case studies, what types of service development took place and when these took place. Our research particularly extends the research of Kindström and Kowalkowski' (2015) by further explaining when the coexistence of basic, intermediate and complex services occurs across the service continuum.

To the best of our knowledge, this is the first study that shows when in the journey firms start launching a combination of different types of services.

Finally, this study provides a mainstream engineering case and two other cases, namely, well-being and learning, looking at the role of technology in service delivery.

## 17.7 Implications for Practice

This research contributes to the field by presenting, first, three actual service journeys and, second, seven stages of the service strategy model that organizations should consider when managing their service journeys. The description of the progression of facts and the reality of these stories differentiate this research from other service transformation, transitioning or servitization studies.

Our findings show that firms compete in the market with a variety of services, from basic to complex ones. This variety has important implications for the operationalization of service business models. Future research should be dedicated to the analyses of the service variety and its correspondent business models in the context of entire service journeys.

## 17.8 Limitations

In social constructionist studies such as this, there is always the question of scientific realism and its counter-defence based on sample size. From the design of this study, we broaden the sample size, not limiting it by numbers; we also explore the journeys at three different levels within the same firms to increase the construct validity of the findings. Moreover, the presentation of findings to two focus groups strengthens the reliability of the findings. Nonetheless, from a scientific perspective and the notion of reality, this study is still limited by its sample size.

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# Chapter 18
# Digital Workers in Service Systems: Challenges and Opportunities

**Paolo Piciocchi, Clara Bassano, Maria Cristina Pietronudo, and James C. Spohrer**

**Abstract** Early forms of AI systems (digital workers), from cognitive assistants to driverless vehicles, are beginning to appear in service systems, creating challenges and opportunities. Meanwhile, people (smarter workers) with an affinity for using advanced technologies are getting things done in new ways. Working scenarios today are guided by high resonant collaboration and wide spread knowledge communication among professionals. To analyze this scenario, we combine both a traditional analytical approach (focus on the parts) and a holistic approach (focus on the whole), privileging a transdisciplinary perspective based on the three frameworks: SSME+DAPP, VSA and IAD. This chapter aims to analyze the challenges and opportunities of digital workers coming to service systems, and provide recommendations for individuals, managers, policymaker, and academics. To mitigate the challenges and seize the opportunities, a wide range of professionals are transforming themselves into T-shaped adaptive innovators in *Smart Working* environments.

**Keywords** Artificial intelligence · Digital workers · Smart working · T-shaped professionals

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_18

## 18.1 Introduction

Because of advances in digitalization and artificial intelligence (AI), early forms of digital workers (smarter machines) are beginning to appear in smartphones as cognitive assistants, in vehicles as driver assistants, and in a range of enterprise applications as chatbot assistants (Spohrer 2016). Currently, digital workers are a type of technology that can accomplish a narrow set of tasks in an assistive mode, but in two decades digital workers will be much more capable (Rouse and Spohrer 2018). Some economists argue that these types of technological advances will eventually eliminate (automate) large swaths of jobs from the economy (Frey and Osborne 2013). Other economists see the economy shifting gears, and as the opportunity to automate production is realized with advanced technology, then distribution of wealth will remain a political challenge (Arthur 2017). Reasonable people can ask "will the transition be smooth, or bumpy for workers whose jobs are on the verge of automation?" Today, the jobs of some professionals may either go off-shore or go to digital workers. Others are asking about future jobs, and how will future jobs provide sufficient income for middle class families? Clearly, there is no shortage of things to be done, i.e., work. However, the continuum of work includes stable jobs, or "good" work that others pay us to do, as well as less stable "gig" work, and even hobbies, which is work we would pay to do, if we have adequate resources (Gershuny 2003). In the coming age of digital workers, perhaps the default mode of the last hundred years, the very structure of organizations (businesses and governments)—paying people a living wage to do the work of business and society—will be replaced by something else. These are interesting questions for service scientists, as value propositions interconnecting service system entities change, but how can the analysis of these hard questions be approached?

Before describing the structure of this chapter, we set the stage by briefly reviewing the forces shaping the evolution of organizations and the workforce, a recent trend called *smart working*, and the notion that work is not only what happens in businesses, but also in society at large. As digital workers come to service systems, will the transition be more about automation or augmentation (Rouse and Spohrer 2018)? Will the transition be smooth or bumpy? How can we analyze this, and what recommendations seem prudent to prepare for multiple alternative futures? Is the best way to predict the future to invent it?

Organizations are benefiting from increased productivity and better analytics, but progress along these dimensions leads to new challenges along other dimensions. For example, through increased productivity and cost savings, the emergence of a more mobile and agile workforce is resulting. The ability to work from anywhere and stay connected through smart phones, tablets, and other mobile devices has enabled employees to stay connected and collaborate with peers and stay on top of digital trends more readily sometimes than even the organizations they work for. These changes impact the workplace by forcing executives and employees to adapt their interactions to the use of technologies, that better enable their work, but simultaneously are accelerating the pace of change. Of course, many specific job

roles are likely to change over time, and employees and executives who seek to fill those job roles must be prepared to compete (Spohrer et al. 2010), while changing structural and cultural elements of their organizations. In the last 30 years, this change has been accelerated by three fundamental trends (Deloitte 2012):

- Aging workforce: Retired workers are taking key knowledge with them, increasing the need to capture their knowledge.
- Information overload: Information is still growing at exponential rates and too often employees can't find what they need, even with technology advances.
- The need for speed: Employees need to work faster and collaborate more effectively to get their jobs done.

R&D organizations today are developing AI systems (digital workers) to address all three of these fundamental trends (e.g., homecare robots, cognitive assistants, and cognitive collaborators).

Today the value of an organization (firm, university, institution) is co-created through multiple interactions among consonant human resources, spanning diverse disciplines, cultures and systems. Workers seek to grow their knowledge, with strong positive attitudes and sharpened capabilities increasing their potential to be employed. The way people search for jobs (website, social network, community, forum) and the way organization recruit candidates (video presentation, on line test) is also changing, but for professionals the concepts of place, time and organization are morphing as well. Questioning the traditional and Tayloristic constraints associated with work place, time and tools gives workers more autonomy while demanding greater responsiveness to producing results. This new managerial philosophy that takes the name of *Smart Working* (Sect. 18.3) demands: greater accountability in achieving goals; learning to manage time; value for the results obtained, not simply for time spent on work; acquiring more cross-cutting skills and knowledge (technologies, communication, tax rules, cultural and relational aspects); learning how to handle relationships in the absence of physical presence (colleagues, clients, superiors, collaborators, suppliers).

The impact of smart working and flexible working environments will require a new framework beyond the traditional relationship between employer and employee in businesses, and begins to enter the realm of societal innovation (ISSIP/NSF 2017):

> "It has been demonstrated that integration of technology to aid human workers can result in dramatic improvements in productivity by augmenting human capabilities in the workplace. In the next few decades human-technology innovations in service systems (Smart Service Systems) will have enormous economic importance for the United States and the world. Smart service systems also have the potential to become the vehicle for social innovations addressing major societal problems."

National constitutions, as well as the governance documents of businesses, universities, and even religions, describe mechanisms for jobs roles to be filled and refilled over multiple generations of people (Spohrer et al. 2010). As global economies encounter shocks to employment, there is a growing need for national policies and incentives to encourage focus on creating the "right jobs and skilled workers" needed for the future prosperity and security of their citizens (Augustine 2005).

This chapter begins to make progress exploring the challenges and opportunities of digital workers (machines) in service systems, including the future of smart working environments and smarter workers (people). The following six sections of this chapter build on some earlier work related to the future of jobs, talent, and smarter working. First, when the opportunity from advanced technologies (sensors, networks, and artificial intelligence) was making cities, states, and nations smarter (less wasted resources), an earlier study examined “three frameworks for studying multi-level governance in nested, networked services systems” arguing that big technology advances often required governance/policy advances to realize the full benefits (Spohrer et al. 2012). That article concluded that an integrated approach combining multiple analysis frameworks was best for analyzing and planning interventions along the dimensions of technology change, policy change, skills change, and cultural (or shared information) change, the same four dimensions that characterize service system architectures. Section 18.2 of this paper further elaborates on the benefits of combining multiple analysis frameworks. Second, to go beyond smarter (more efficient use of resources) and to get to wiser (more opportunities for individuals and higher quality of life for families in a resilient society) service systems in a world with cognitive mediators (personal digital workers), three related articles explored the idea that augmented intelligence would lower the cost of startups, and lead to a more entrepreneurial workforce of the future empowered by digital workers (Spohrer and Banavar 2015; Spohrer 2016; Spohrer et al. 2017). Section 18.3 of this chapters delves more deeply into smarter working based on recent research coming from Italian researchers. Third, when the concern was recession and off-shoring of jobs, an earlier study examined “how people change job roles” either because they are let go or because they are seeking new challenges (Spohrer et al. 2010). That article concluded that T-Shaped Professionals, with depth and breadth, were better positioned to change job roles that I-Shaped Professionals, with only depth. Section 18.4 of this paper further elaborates on the benefits of T-Shaped Professionals in the era of digital workers. Service science is the study of the evolving ecology of service system entities (e.g., people, businesses, nations, universities, etc.)—and so the changing nature of work is a suitable subject for study by service scientists. In Sect. 18.5, we summarized recommendations for individuals, managers, policymakers, and academics as service system entities embedded within other service systems (e.g., families, businesses, nations, and universities). In all of these roles, workers are balancing two primary goals: (1) to transform into the best possible future version of themselves, and (2) to ensure the same for the most significant service systems they are embedded within, respectively family, business, nation, and university. In Sect. 18.6, we present concluding remarks, limitations, and future research directions.

In sum, the next section (Sect. 18.2) presents a transdisciplinary perspective on the three frameworks SSME+DAPP, VSA and IAD. All three frameworks are used to analyze complex human systems and can help organizations interpret the real-world problems in labor markets. Section 18.3 highlights an important new trend,

*Smart Working*, and clarifies concepts and terms related to smart working environments. Section 18.4 proposes a series of characteristics that smart workers should have in this dynamic environment, highlighting the benefits of T-Shaped Professionals. Section 18.5 summarizes the recommendations and practical implication for individuals, managers, policymakers, and academics. Finally, in Sect. 18.6, implications, conclusions and future research directions are discussed.

## 18.2 Methodology

In this section, we describe three frameworks for analyzing the challenges and opportunities arising from increased digitalization in business and society, including digital workers in service systems. Our human ecology (Hawley 1986) is changing itself at an accelerating rate. Researchers are struggling to keep up—to analyze real-world problems, to understand options, and to recommend changes that benefit the whole and not just a few parts. The challenge is to make better recommendations faster and build a smarter planet (Spohrer et al. 2012). Figure 18.1 shows an instrumented, interconnected and intelligent planet able to trigger co-creative processes, inside and between systems. Our planet is composed of diverse and interconnected systems. All aspects of our modern society can be viewed as nested, networked systems (industries, institutions, healthcare, transportations, educations, cities). In this context, academic researchers and faculty strive to understand, grow, and propagate symbolic knowledge, while managers and policymakers strive to translate knowledge into value/benefits for business and society (Spohrer and Maglio 2010a, b).

One of the goals of service science is to create a smarter planet of instrumented, interconnected, and intelligence smart service systems (Spohrer & Maglio, 2010a, b). The resilience of service systems (design for rapid rebuilding from scratch) requires innovative entity architectures for holistic service systems (HSS) that provide "whole service" to the people inside those HSS (Spohrer et al. 2012). Such innovative entity architectures specify sequences of resource usage, resource

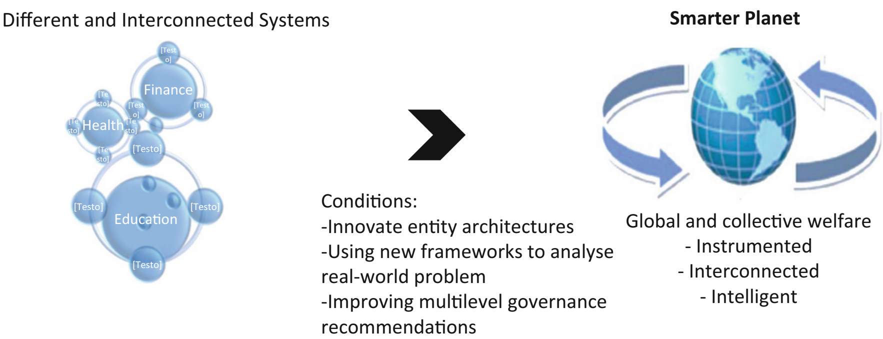


Fig. 18.1 Elaboration of Smarter Planet (Spohrer et al. 2012)

characteristics, roles, value proposition relationships, decision-making rules, and governance structure for a holistic service system. A holistic service system provides whole service to the people inside and is a system of components and networks of relationships that make the whole service offering more than the sum of its parts, considering overall part performance (Patrício et al. 2011). Today, a new set of recommendations is needed to address labor market evolution, and the recommendations should be co-created to address the needs of all stakeholder entities in the nested, networked holistic service system. To make progress, business leaders, politicians as well as scientists need new concepts for the future (Mrass et al. 2017). Societal systems continually interact with their environment via individuals in job roles, however behaviors and dynamics of these diverse types of viable systems are not easy to explain and predict (Beer 1972).

Indeed, to shed light on many real-world phenomena, and to provide practical recommendations to prepare a next-generation of individuals to seize opportunities and compete better in a world of accelerating change, including jobs roles (Spohrer et al. 2010), three frameworks are considered: Service Science, Management, Engineering, plus Design, Arts and Public Policy (SSME+DAPP, or just SS for short); Viable Systems Approach (VSA); and Institutional Analysis and Development (IAD). Through these three complementary frameworks, a transdisciplinary perspective is privileged to understand an impending challenging problem—new scenarios in labor market on the verge of being flooded by low-cost digital workers as every smartphone app "grows up" to become a digital worker. The labor market is part of a nested, networked structure of holistic service system where people fill multiple roles in the course of their lives in a great variety of service systems. SS is an emerging transdiscipline that studies the evolving ecology of nested networked service system entities, their capabilities, constraints, rights, and responsibilities, as well as their value co-creation and capability co-elevation mechanisms (Spohrer and Kwan 2009; Spohrer et al. 2017). The main purpose of SS is to (Spohrer et al. 2012):

1. Identify all stakeholders, including providers, customers, competitors, and governing authorities, in a network under study (a transdisciplinary network analysis is always a portion of the full ecology).
2. Gather stakeholder reports from as many stakeholders as possible (e.g., challenging problems and potential opportunities).
3. Recommend and evaluate proposed changes that existing stakeholders can make and are willing to make (e.g., interactions, outcomes).
4. If unresolved problems and opportunities remain, recommend and evaluate proposed changes in the number/type of stakeholders (e.g., entities), and repeat analysis.

SS also studies both technology system innovation and rule system innovations, and how they integrate in different types of service systems (Spohrer et al. 2010; IfM and IBM 2008). In this era of cognition as service, human knowledge, skills and experiences will be greatly augmented by machines (cognitive assistants) that help to build a smarter/wiser service system ecology (Spohrer and Banavar 2015: Spohrer

2016; Iwano and Motegi 2015). SS can provide tools to re-interpret the real technological world and define new entities architecture.

The VSA framework is an approach to study the viability of systems in a complex environment. VSA makes progress possible by starting with an analysis of the objective survival and subjective ability to respond to environmental change generated by viable systems (Golinelli 2010; Barile and Saviano 2011; Golinelli and Bassano 2012). Viability is a relevant concept to measure how well systems can optimize their own development in relationship to their social context and environment (Spohrer et al. 2017; Piciocchi et al. 2011). Viability depends first and foremost on a government capability to self-govern and manage external relationships that create value for the stakeholders or suprasystems and it requires a type of win-win logic, or non-zero-sum games between involved systems. The relevant characteristics of VSA include (Spohrer et al. 2012):

1. Entities: Stakeholders or suprasystems;
2. Interactions: Dynamics through time between entities;
3. Outcomes: Degree of system equifinality between entities.

To be viable, each system has to attain consonance—structural compatibility or adequacy between different entities (basic condition to co-create value)—and resonance—concrete outcome of the interaction between these consonant entities and direct cause of value creation (Piciocchi et al. 2009). However, a greater level of integration among viable systems is obtained from shared value categories; but to obtain superior conditions of consonance and resonance, in addition to value categories, also interpretative schema, and informative units should be shared between interdependent viable systems (Barile et al. 2013c; Barile 2009a; b). The VSA framework also provides a clear reading and interpretation of the issue of stability in nested networks, since networks depend, primarily, on the role and capabilities of the component entities to interact considering the reciprocal influences and the critical bearing of resources available to the structure (Spohrer et al. 2012). Both Service Science (SS) and Viable Systems Approach (VSA) take a systems science approach to the study of human society, and moreover both seek to identify and clarify mechanisms for the continuous improvement of quality of life in society (Spohrer and Maglio 2010a, b; Golinelli 2010). The human systems are complex and can be seen as instances of nested, networked holistic service systems that provision whole service to the people inside them and depend heavily on shared systems of rules that change over time (Spohrer et al. 2012). In these nested, networked, complex human systems, it is rarely that case that solving a real-world problem equates to solving a single-discipline, single-system, or a single-culture problem. More frequently, solutions to real-world problems equate to solving multiple-discipline, multiple-system, and multiple-culture problem, and co-creating new types of entities (roles), interactions (value propositions, rules), and/or outcomes (ecological structures, dynamics) (Spohrer et al. 2012).

Gummesson (2010), the father of service network theory, has suggested that the service research community would benefit from a deeper understanding of the Institutional Analysis and Development (IAD) framework (Ostrom 2009), because

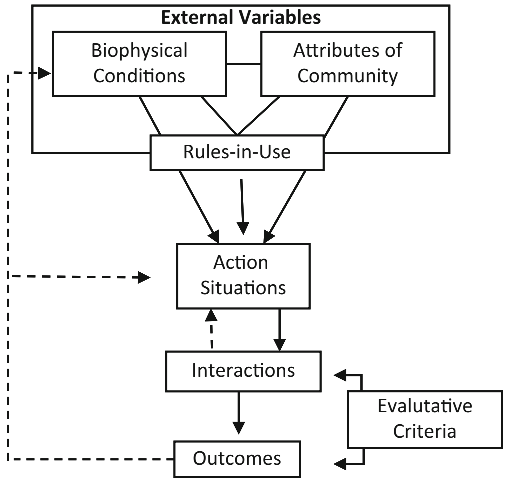


**Fig. 18.2** Elaboration of a framework for Institutional Analysis Design (Ostrom 2005)

IAD helps to better understand collective problems. The IAD framework analyzes action situations that lead to interactions and outcomes (Ostrom 2011). An action situation refers to the social space where participants with diverse preferences interact, exchange goods and services, solve problems, dominate one another, or fight (among the many things that individuals do in action arenas) (Ostrom 2005). Furthermore, IAD considers external variables (rules, biophysical world, and community) from the ecological ecosystem and socio-economic-political setting, that could influence the action arena (Ostrom 2005, Fig. 18.2). Particularly, combinations of rules affect the actions and outcomes (Spohrer et al. 2017). With respect to rules, Ostrom (2005, p. 18) states that all rules are the result of implicit or explicit efforts to achieve order and predictability among humans by creating classes of persons (positions) who are then required, permitted, or forbidden to take classes of actions in relation to required, permitted, or forbidden outcomes (Ostrom 1997; Crawford and Ostrom 2005; Ostrom 2011; Siddiki et al. 2011). Therefore, to solve collective problems and obtain positive results for a system, a shared system of rule should be designed, but it shouldn't be interpreted as a system of social habit, consolidated and static. Participants should be aware that rules influence their relationship with other actors in the system and if interactions change, also system of rules should be change.

The IAD framework, requires building multi-tier conceptual maps Ostrom (2011). Then performing Social, Ecological, Political Settings analysis, i.e., for a dynamic system in continuous change, trying to identify and organize relevant variables that mutate the system, and once identified can be leveraged to enhance the system performance. The IAD framework analysis generates multiple views, including Resource System, Resource Units, Governance System, and Actors embedded in larger or smaller Social, Economic, and Political Settings and Related Ecosystems, and the way these might affect interactions and outcomes, see Fig. 18.3 (Ostrom 2007).

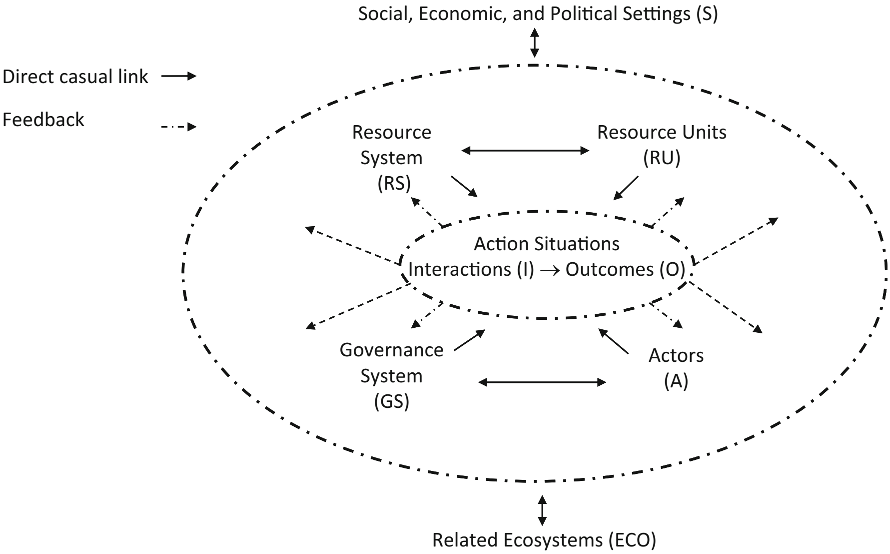


**Fig. 18.3** Elaboration of Action Situations embedded in broader Social, Ecological, and Political Settings (Ostrom 2007)

Within IAD, the relevant variables depend on the specific research question of interest (Ostrom 2011). This makes the framework useful to take on varied and often complex issues. Our research question concerns changes taking place both by organizations and workers in labor market and that are modifying outcomes and interactions. Avoiding grave distortions means establishing a new set of shared rules that act on value-proposition-based interactions between all actors and entities.

These three analytic frameworks (SS, VSA, IAD) are diverse, but with overlapping concepts. All three exist to improve our understanding of complex systems and help stakeholders to "explore" a complex human system design space. "Explore" implies real-world problem analysis in terms of multiple disciplines, systems, and cultures (Spohrer et al. 2012). Today, organizations depend on their ability to interpret an ever-changing world, but this is not easy, considering the number of entities involved, their mutual dependence and the contingent difficulties in schematizing the whole (Spohrer et al. 2010). Therefore, decision makers constantly strive to formulate new interpretative schema (frameworks) to re-design the service system ecology, identifying an appropriate solution for their business or government enterprise and for the whole system. After two centuries of rapid technological change, frameworks are still unable to predict future jobs and changing job roles within service system entities (Spohrer et al. 2010); nor are organizations today, able of to manage this process of change, beyond insights about what becomes routine work, and what requires mode complex communication and problem-solving skills, considered by Levy and Murnane (2004). Dealing with new levels of complexity requires new types of decision making, therefore, pattern or schema must be created (Barile 2009a, b).

## 18.3 An Innovative Scenario

In this section, we examine some of the innovative responses to the challenges created by increased digitalization of organizations. Wide acceptance of mobile technologies has made the world a smaller place, reducing it to one place: our screens (Saxena 2016). Apps on smartphones are transforming the activities of people not only during their shopping or in their personal relationships, but also at work. New models of work are spreading, revolutionizing Tayloristic models (job in a factory, card-punching) that are no longer adapted to the current context. Durward et al. (2016), defines "digital work" as "effort to create digital goods or that makes substantial use of digital tools". However, it is not an issue of technical equipment or devices possessed by organizations, because at the center of a smart (work) environment, like the present, there are always users (Ducatel et al. 2001; Cook et al. 2009; Mavrommati and Darzentas 2006). Today, consumers, workers, citizens are continually connected, informed and aware through applications and devices. However, as technology advances, the concern of being made redundant or replaced by machines also exists. Moreover, according to Demirkan et al. (2015) a whole system approach is needed, not only businesses, but also societal systems are transforming, as they gain technological capabilities, such as instrumented (sensors that have the ability to measure the exact condition of everything), interconnected (data stored in the cloud and accessible from mobile devices), and intelligent (cognitive systems provide high-quality recommendations and help individuals to make better data-driven decisions). Low cost technology is increasingly accessible to more people to improve productivity, but often new rules and policies are needed to improve quality of life, and to make systems both more productive and sustainable.

Also, Clapperton and Vanhoutte (2014) adopt a systemic concept defining smart working through dimensions of space, technology and people, where management makes the business more effective and delivers right result respecting the planet. From this definition, it is deduced that the smart approach requires the adoption of policies oriented toward flexibility, the reconfiguration of work spaces, the use of new technologies and even new managerial cultures in order to achieve systemic benefits both in terms of effectiveness and efficiency.

### *18.3.1 Smart Working*

Smart Working is *a new managerial philosophy that restores to people flexibility and autonomy in the choice of spaces, schedules and tools to be used in the face of greater responsibility for the results*. According to The Smart Working Observatory of the Politecnico School of Management (Politecnico di Milano 2012), it's a new approach to organize work in order to "drive greater efficiency and effectiveness in achieving job outcomes through a combination of flexibility, autonomy and collaboration, in parallel with optimizing tools and working environments for employers"

(CIPD 2008, p.4). Smart working studies only recently have emerged in international literature (Sarti and Torre 2017), defining the phenomenon as an innovative approach to work organization (Sarti and Torre 2017; CIPD 2008; Lee 2013; Boorsma and Mitchell 2011). Brewer (2000) states that this new way to organize work was challenging the conventional model of work design overcoming hierarchical managerial style and focusing on control. Smart Working is viewed as one of the top tactics to improve productivity (CIPD 2014a).

The smart working observatory (Clapperton and Vanhoutte 2014) identifies three main elements on which to act to adopt this managerial philosophy:

1. Bricks, the physical layout of the workspaces;
2. Bits, the ability to exploit the potential of digital technologies for the rethinking of the virtual space of work;
3. Behaviors, in terms of diligent styles and organizational policies, top management culture and people's behavior.

Technologies and spaces are just the tip of an iceberg that hides a profound cultural change in organizations, one that is highly dependent on governance choices. Smart working isn't just the aesthetic set of office layouts or technology applications to obtain logistical savings and reduction of work stations (Iacono 2013), but is a complex approach that, innovating tools and spaces, triggers a collaborative and integrated process between people and organizations. Both people and organizations (service systems) become more adaptive, agile and capable of creating innovations, evolving the workforce to meet businesses and societal opportunities (CIPD 2014b). Giving to people greater flexibility and autonomy in the choice of spaces, working hours and tools to be used to carry out their work is an empowerment approach, making people responsible for results, while encouraging growth of talent and creativity, allowing also a better balance between quality of life and individual productivity (Iacono 2013). Furthermore, social computing and collaborative communication technologies are now creating immense possibilities for stimulating collective intelligence, providing new opportunities for learning both outside and inside of organizational boundaries. Smart working is an outcome of the process of designing organizational systems that are built to exploit work-force knowledge, skills, potential for learning and require everyone's participation to successfully innovate an organization (McEwan 2016).

Therefore, the center is not the technology or the physical space, but the needs of individuals and organizations to be better adaptive innovators, seizing new opportunities. The focus is on the outcomes that can be achieved in an increasingly collaborative, free, creative work environment, where *mobility* is not a choice and not an obligation (Mitchell 1996), *sharing* is an opportunity to be exploited and not a restriction to be faced and the *development* of relations a strategic mode of value creation (Iacono 2013). Although hyper-technological, automatized, robotic, today's organizations are knowledge-based organizations, and based on the collective knowledge of their employees, located wherever their devices are located. For this, the main problem area is the need to develop a mechanism for tapping into the collective intelligence and skills of employees in order to create greater

organizational knowledge (Bollinger and Smith 2001). Smart space and technologies facilitate this by multiplying the number of interactions between external, internal and foreign resources in organizations, sharing platforms and co-working spaces. Individual knowledge, if not shared with others, will have very little effect on the organizational knowledge base. Therefore, one of the important tasks for management is to facilitate the process of interactions between employees and make them sensitive toward environmental stimuli so that their individual knowledge is amplified and internalized to contribute to the organizational knowledge base (Nonaka 1994; Bhatt 2002). Enriching cognitive competences during interactions across space and disciplines, ensures that workers become smarter and cannot be replaced by a computerization of the labor market. Considering that currently organizations are a part of a whole system composed by institutions, other firms, citizens, these interactions should be favored to spread and share a common culture, promoting a systemic knowledge management, but first of all avoiding a destruction effect caused by technologies that reallocate labor supply (Frey and Osborne 2013).

### *18.3.2 Beyond Smart Workplace*

Gone are the days when the workplace was merely a physical space of employees occupied during regular office hours (Deloitte 2012). Environments always connect, and open use of technology invites participation and knowledge-sharing from inside and outside of organizations, supporting collaboration (CIPD 2014c). For several years, leading organizations have been experimenting with new working environments: home, co-working space, the branch/office closest to home, and/or everywhere mobile. The most popular option (Adecco 2015) was mainly at home (23% recruiters vs 55% job seekers), followed by co-working offices (22% recruiters vs 33% job seekers), company offices near employees' homes (21% recruiters vs 43% job seekers) and working on the move (18% recruiters vs 31% job seekers). However, very often flexible workplaces are still perceived as a barrier to a productivity, although several studies (Nauert 2011; Ahuja et al. 2007) have reported otherwise.[1] Line managers and senior managers are concerned with the quality of work produced by staff working remotely, because they no longer have direct control on when and where employees work (CIPD 2014c). This is why the key to success lies in the effective implementation of a true cultural change (Deloitte 2012): trusting relationships with their teams, meeting workers expectations and motivations, stimulating participation in the creation of knowledge; developing capacity for innovation; awareness of the value of cooperation, of fair exchange within the

[1] Ahuja et al. (2007) show an increase in worker productivity, which thanks to greater autonomy and involvement increases work performance by 50% and, if combined with the reduction of overtime and absenteeism, leads accordingly to a significant reduction in labor costs. Nauert (2011) believes that the company Smart, by giving staff the possibility to choose where and when work, makes the employee satisfied, increase engagement and productivity.

organization; promoting a sense of belonging among the staff, attention and cultivation of the ability to open up with customers and suppliers communications to create relationships of mutuality and mutual satisfaction. Particularly, the leader/manager must possess seven key characteristics (Kramer 2005):

- open mind and flexibility to easily adapt to new ways of working and interacting with every type of person;
- interested in news and new cultures;
- able to manage complexity and make decisions that involve radical changes in the context such as the adoption of Smart Working;
- elasticity and optimism to incentivize their staff;
- trust relationships with its collaborators;
- stable personal life and credibility.

## 18.4 Talent Planning for Smarter Workers

In this section, we explore the future of talent as smarter workers (people) learn to manage their increasingly large and capable digital workforce (machines) in smart working environments. The digital workforce will evolve in part from smartphone apps, as those apps gain voice interfaces, episodic memories, and models of their users. Eventually every person will have to learn to manage a digital workforce of hundreds of digital workers available to help them with a wide range of work, life, and citizenship matters. Entrepreneurs and entrepreneurial teams will especially benefit from having a low-cost digital workforce, expanding their capabilities, and enabling them to seize diverse opportunities. The shift to smart working can be seen as a shift toward empowering internal entrepreneurs and giving freedom to entrepreneurial teams to focus on dynamically shifting opportunities that are most meaningful to the organization (whole) and the individual employees (parts) as they seek to develop their professional careers. Both the whole and the part are service systems entities working to transform themselves into their best possible future selves.

An organization can try to adopt smart working practices, but no strategy will be successfully without smarter workers. Even though information technology has changed the ways in which employees connect, collaborate and communicate (Deloitte 2012), not all are ready to adopt smart working practices. Supporting collaboration while employees are mobile is increasingly important (Reif et al. 2001). Employees are not only nomadic users (Schiller 2003), but also nomadic workers, individuals or small groups that conduct their work across different physical spaces, utilizing a variety of interactive devices either on their person (handhelds, wearables) or in their environment (wired environments), (Ciolfi et al. 2005). Nomadic workers are characterized as curious, inclined to change and suspicious of non-flexible managerial styles. However, the flexibility of space and time can cause distractions for workers, therefore to respect the agreed delivery terms, it is essential

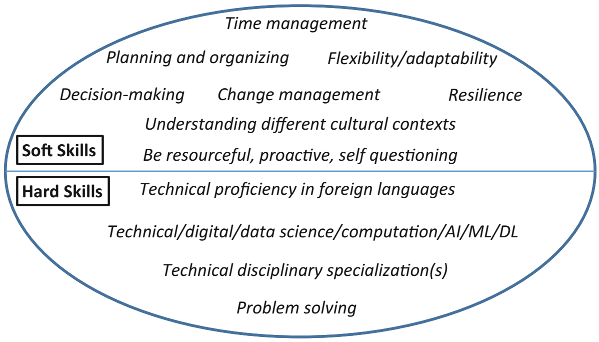


**Fig. 18.4** Hard and soft skills of smarter workers

to acquire new skills, attitudes, and competences. Smarter workers must be able to constantly re-invent themselves in a broad collaborative and competitive context, where digital workers and other smarter workers are a key part of the new workforce and ready either to augment or replace them. It is, therefore essential to develop cognitive and relational skills that cannot easily be replaced by digital workers (machines). Smarter workers should be able to manage long-distance professional relationships effectively and communicate well, both verbal and written, to keep up with the faster pace and by using effective, up-to-date technological and communication tools.

Figure 18.4 show a series of skills (hard and soft) that smarter workers should have.

Technical specializations—hard skills—are fundamental, but in time could be replicated and optimized by digital workers (machines). It is also important that smarter workers have flexibility, adaptability and resilience—soft skill—(trivially, the need to conduct meetings in unusual times, due to time zone). Social intelligence is nascent but still lacking in digital workers, as are other human capabilities and qualities (Frey and Osborne 2013). A study carried out in 2015 by Smart Working Observatory of Politecnico di Milano and Doxa, an Italian institute specialized in survey and market research, has identified five profiles of workers:

1. Knowledge Workers: Employees in activities that require a high degree of adaptive expertise and problem-solving concentration/specialization, and who benefit from the flexibility introduced by smart working.
2. Multitaskers: Employees who alternate activities, balancing collaboration and communication as well as problem-solving concentration.
3. Collaborator: Employees for which collaborative activities predominate in person or through digital technologies.
4. Communicator: Employees who do mostly direct communication.
5. Contemplator: Employees who are creative and collaborate well with others.

However, only the first three are a good fit for working in a smart working environment, assuming they have well-developed soft and hard skills. Typically, traditional knowledge workers should develop more soft skill to reinforce flexibility and a resilient attitude; the traditional multitasker may need to plan and organize

better across locations and time zones, without neglecting constant growth of technical and digital skills; the traditional collaborator can strive to constantly deepen their hard skills while taking advantage of collaborative learning from others. Typically, the latter two are too specialized, so they should improve both soft and hard skills. The practices of existing educational institutions will need to change as well to prepare graduates for smart working environments. Therefore, the issue becomes more and more systemic, involving institutions and other organizations that should adopt consonant schemas to mold/forge a new generation of smarter workers.

### *18.4.1 The Shape of Professionals*

An integrated SS-VSA analysis (Spohrer et al. 2010) of the “shape” of professionals who can best grow and thrive (social, technological, scientific, economic) in dynamic environments, revealed the benefits of T-Shaped Professionals (TSP), who balance soft skill breath and hard skill depth. Digital tools accessible by both digital workers (machines) and smarter workers (people) are required to continuously upgrade worker capabilities. For this reason, knowing “the shape of professionals” can help organizations and institutions better forge individuals who know how to adopt new tools not only in a single specific context, but also when rapidly shifting between contexts (Barile et al. 2013a). The study of the “shape of professionals” is a way of talking about the capabilities that professionals can apply when they are solving problems and collaborating with others. T-Shaped Professionals (TSP), see Fig. 18.5, are characterized by depth and breadth of knowledge in different areas of study (Donofrio et al. 2009), and are able to communicate with other professionals with a different background. A person with depth has specific knowledge in one discipline area or system and vertical competencies (i.e. analytic

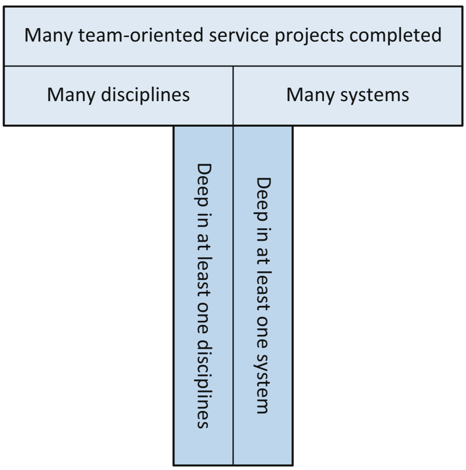


**Fig. 18.5** Elaboration of A T-Shaped Professional in Service Science (Spohrer et al., 2007, 2010; Spohrer and Maglio 2010a, b)

thinking and problem solving), (Barile and Saviano 2013). At the same time, TSP possess a breadth of soft skill or horizontal competences (i.e. project management, organizational culture, communication, critical thinking, team work, network, etc.), (Barile and Saviano 2013). Briefly, TSP understand the vocabulary of other disciplines, other systems, and use it to comprehend and describe problems, that others may not be able to understand or solve.

TSP can be better decision-makers in smart working environments, managing complexity and living with changes (elasticity and flexibility plus efficiency). They are most suited to be collaborative thanks to their cognitive specialization and relational attitude (mediation contribution and participation in value co-creation and sharing value), especially in co-working environments. Several studies (Johannessen et al. 1999) suggest that T-shaped skills influence positively the creation of knowledge, because they can integrate diverse knowledge assets, representing a relevant source of competitive advantage especially in conditions of high complexity (Barile and Saviano 2010). Such balanced expertise profiles should be capable of facilitating relationship growth in smart working environments (Piciocchi et al. 2017, p. 186):

1. fostering a culture of innovation;
2. generating and intercepting good business ideas, products, services, mainly based on innovative technologies, the exploitation of research results, methods of sharing knowledge and skill across different experience levels;
3. promoting comparison and exchanges among the carriers of ideas or more established businesses, to start motivational growth paths of business culture capable of raising the quality and competitiveness of local production systems and creating business networks;
4. developing existing enterprises, encouraging consolidation processes on the market, innovation, networking and internationalization.

However, in response to automation of tasks, the T-shape model should be reformulated for a new generation of smarter workers (Fig. 18.6), becoming

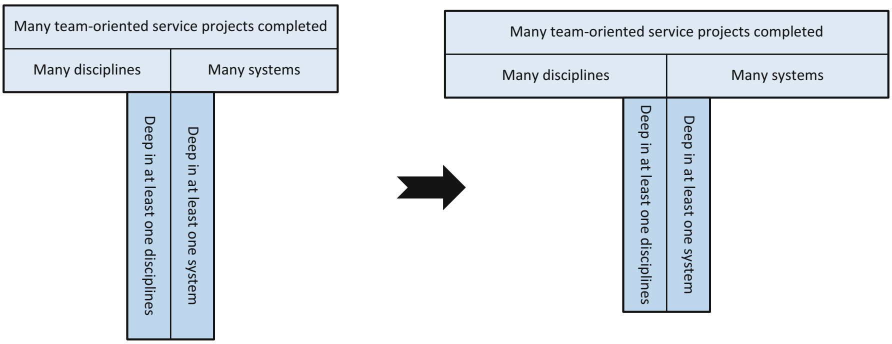


**Fig. 18.6** From a classical configuration of T-Shaped Professionals to a new configuration of TSP: somewhat less depth and more breadth

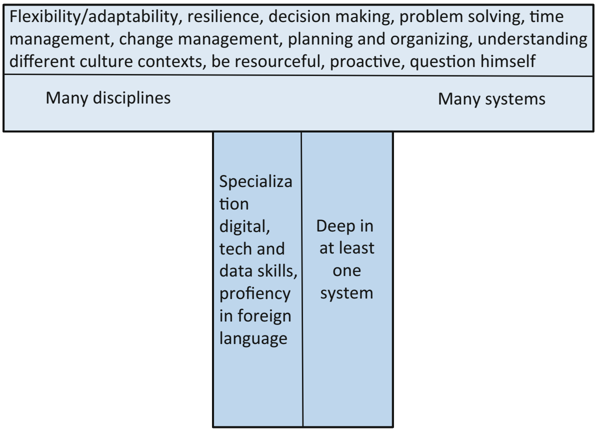


**Fig. 18.7** T-Shaped Professional (TSP) for smart working organizations

somewhat less deep and somewhat broader, developing a creative social intelligence, useful in the race against technology for jobs (Frey and Osborne 2013).

According to Barile et al. (2013a, p. 283), therefore, complexity imposes a return to capacity (breath) to deal with decisional contexts in which the skills possessed (depth) are inadequate. A greater emphasis on capacity (breadth)would provide a better fit to smart working contexts, if it is enriched with those soft skills identified in Fig. 18.4. Figure 18.7 shows soft and hard skills adapted to a new T-shape model. Hard skills, that represent competences of smarter workers, aren't insignificant, but they have to be more adaptive, and provide a foundation for rapidly learning new areas of technical depth.

However, having more breadth capabilities, does not mean becoming a generalist, but instead becoming generalizable (Macaulay et al. 2010). Depth in multiple disciplines is even better than depth in one discipline, though multiple areas of depth are typically costly to attain (Barile and Saviano 2013). What is needed is a general level of knowledge that can be usefully applied in different contexts to face the variety and variability of phenomena, that also allows learning to be deep in multiple areas more rapidly than before (Barile and Saviano 2013). The new configuration (Fig. 18.7) provides workers with new interpretative schemas, more adapted to understanding and decision-making in a complex reality. Nevertheless, actions and choices should be addressed by the system of value categories that filter to the incoming variety and characterize the system in a distinctive way (Barile et al. 2013a). Therefore, it is necessary to change human capital focusing on education that helps students to become more T-shaped. Universities and higher education institutes will have a critical role, as they are already known to be critical stakeholders in providing basic scientific knowledge for industrial innovation, through research, teaching, and learning (Ferretti and Parmentola 2015; Bakar et al. 2017).

## 18.5 Practical Implications

As digital workers come to service systems, the challenge and the opportunity is the same: transformation. Individuals, managers, policymakers, and academics are all historically balancing two primary goals: (1) to transform into the best possible future version of themselves, and (2) to ensure the same for the most significant service systems they are embedded within, respectively family, business, nation, and university. To balance these two transformation goals means shifting towards entrepreneurial capabilities in smart working environments. Given these transformations goals, the recommendations can be summarized as follows:

Individual: Individuals work to balance the transformation of themselves and their families (or another relevant social-emotional support group). As discussed in the last section, much of this work relates to developing their talents in context as T-shaped adaptive innovators.

Manager: Managers work to balance the transformation of themselves, their employees and their business. Managers work to re-design organizational structure and process to support the new generations of smarter workers (people) who know how to use digital workers (machines) to get better transformation outcomes. For example, CIDP (2014c, p.19): (1) In terms of organizational structures: use technology to share knowledge and collaborate inside the organization; create cross-functional working teams and self-managed or self-directed teams; have non-hierarchical structures; use workplace design to support collaboration (for example employees from different departments/roles sit together); open use of technology to invite participation and knowledge-sharing from outside of the organization. (2) In terms of job design: develop leadership and management capabilities that fosters staff involvement and participation; select smart people with T-shaped skills; employees select their own tasks within a defined project; job roles have time ('slack') to built-in for experimentation and rapid response; commission outcomes (no fixed hours, only an output target). (3) In terms of work processes: quality circles/total quality management; reduced documentation reliance; iterative work processes (for example sprints, feedback loops); the 'Business Excellence Model' or equivalent; increasing decisional weight to human resources. (4) In terms of performance and reward: 360° feedback; assigning tasks and assessing progress by competency, not role; values-based rewards; share options for all employees.

Policymaker: Policymakers work to balance the transformation of themselves, their fellow citizens, and their regional government and institutions at multiple levels (city, state, nation). Policymakers focus on quality of life of citizens in regions, so that they meet the demand and supply of labor, which are linked to the educational and economic system. New educational models should be able to create capacity and knowledges useful to operate in fast changing environment. The ambitious project to create a smarter planet requires T-shaped talents to give a global and collective vision of our planet, managing complexity requires new interpretative schemas (Barile et al. 2012b), therefore, it would be necessary to resort to a multilevel smart governance that knows how to implement the right strategies and assign the right roles to the actors/entities involved to solve a systemic problem.

Academic: Academics work to balance the transformation of themselves, their students and their universities. Academics, particularly service researchers, may benefit from improved frameworks to analyze/design complex human systems (1) integrating across diverse disciplines, systems, cultures; (2) improving multilevel governance making it more likely that optimizations contribute to global resilience and sustainability; (3) moving beyond dyads and assuming the configuration of nested, networked systems in the wild, as Ostrom has done with IAD (Ostrom 2005).

## 18.6 Conclusions, Limitations and Future Directions

Over the next two decades, digital workers will become increasing capable, low cost, and abundant. The sudden changes in the world of work will create the risk of destabilizing organizations that may be unprepared or slow to face challenges. While business and society slowly transform to realize *Smart Working*, AI advances accelerate and could replace millions of traditional workers with digital workers (machines). Devices that are used today to facilitate the task of workers could replace human tasks. This possibility would involve a series of social and economic steps. Forty-seven percent of total US employment is in the high-risk category, potentially automatable over some unspecified number of years, perhaps a decade or two (Frey and Osborne 2013). Indeed, it has been estimated that the cost of digital workers will decrease sharply, passing from a petascale computational systems to an exascale computational systems over a period of forty years. The problem to be addressed is therefore systemic, it will concern businesses and institutions and individuals who will have to commit themselves to formulate training programs, emphasizing the right technical (depth) and social (breadth) skills Some economists see the labor of people becoming increasingly less central in economic production, but the task of companies and institutions is precisely to prepare for change. Even if industry has been known to be more dynamic and faster changing than academia (Donofrio et al. 2018), universities are increasingly animators of social development (Ferretti and Parmentola 2015). Researchers should continue to formulate or reformulate models that can support organizations and institutions, helping them to reinterpret normative and educational programs. Smarter/digital workers need to learn T-shaped skills whereby they are reasonably specialized, but also with the capability to make decisions and solve problems in communication and collaboration with more and more diverse stakeholders. Moreover, they should direct managers to operate with a transdisciplinary approach, that goes:

- beyond the business structure and towards the whole context (Barile et al. 2012a);
- beyond individual knowledge, competences and capabilities that alone are not enough to manage the various dimensions involved in social and economic dynamics (Barile and Polese 2010; Barile et al. 2012a) and different combinations of these factors (Barile et al. 2013b; Saviano et al. 2016).

A great deal of work remains to make this conceptual work more rigorous, and future research directions aim to build better simulation tools to be used by service scientists toward that end.

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# Chapter 19
# Visualizing and Improving Service Processes with PCN Analysis

**Scott E. Sampson**

**Abstract** This chapter introduces the service design and improvement tool known as PCN Analysis. PCN Analysis focuses on the ways in which processes can be strategically designed to leverage interaction between firms and their customers. PCN Analysis visualizes and optimizes along elements of customer value, provider value, customer-provider interactions, customer roles and responsibilities, provider and customer resources, and interconnectivity of service networks. Potential objectives of PCN Analysis include improving process control, leveraging expertise and other economies of scale, improving process efficiency, and increasing the potential for customization. These objectives are achieved through a method of "strategic process positioning," where processes alternatives are explored and design implications are considered.

**Keywords** Service design · Service improvement · PCN Analysis

## 19.1 Introduction

In this chapter, we add some science to the art of service design and innovation. The method we will present is a structured approach that involves documenting a context for innovation, ascertaining customer needs and improvement opportunities, enumerating service configuration alternatives, and identifying superior alternatives. This method has been taught to undergraduate, MBA, and Executive MBA students for a number of years with tremendous results. In all instances, students have been able to identify practical service innovations through this method, including innovations involving relatively complex service processes.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_19

The next section will briefly review the characterization services. The PCN Analysis methodology for service design will be reviewed as it pertains to service innovation. The concept of strategic process positioning will be expounded and examples will be described. Methods for applying PCN Analysis in systematic service innovation will be described through a case study. The penultimate section discusses extended applications of the methodology and a final section summarizes.

## 19.2 Services as Customer-Interactive Processes

Services have been depicted in research and academic literature in various ways. The most common traditional depiction of services is according to the so-called "IHIP" characteristics of intangibility, heterogeneity, inseparability, and perishability (Nie and Kellogg 1999). The IHIP perspective has fallen out of favor in segments of the academic community. Leading service management researchers have called IHIP characteristics "misleading", a "misrepresentation," and "service mythology" (Grove et al. 2003, p. 115; Lovelock and Gummesson 2004, p. 37; Vargo and Lusch 2004, pp. 326–327).

A different perspective views services as customer-interactive production processes. For example, Nie and Kellogg (1999) surveyed 197 operations management professors about their perceptions of services. Their survey revealed serious doubts about the managerial salience of the IHIP characteristics, instead revealing that customer contact/interaction/participation with service operations has the greatest impact on strategic decision-making.

This idea was espoused some time earlier by Chase, who provide a "customer contact" model of services that has numerous managerial implications (1981, 1983). Chase defined customer contact as "the physical presence of the customer in the service system," which he correlates with "the degree of interaction between [the service system and the customer] during the production process" (Chase 1978, p. 138).

Sampson and Froehle (2006) built on the customer contact model in the so-called "Unified Service Theory," which identifies customer contribution to a provider's operations as the universal distinguishing characteristic of all services. The requirement for customer contribution precipitates interaction between the customer and the service provider, either direct (person-to-person) interaction or indirect interaction (i.e., a provider interacting with customer-provided resources).

In this chapter, we will assume the view that services are *processes that involve coproductive interaction between providers and customers*. Specifically, we will consider the permutations of the coproductive roles between producers and customers. As Demirkan states, "A key characteristic of service innovation is that it often changes the roles of providers, coproducers, and customers of services and alters their pattern of interaction" (Ostrom et al. 2010, p. 15). That is the focus of our approach.

## 19.3 PCN Analysis: Tool for Service Innovation

The basis for our service innovation approach is PCN Analysis, a tool that was introduced by (Sampson 2012). That initial exposition of PCN Analysis reviewed the mechanics of PCN Analysis, compared it to alternate service design methodologies such as service blueprints and BPMN, and outlined managerial implications of service design alternatives.

That 2012 exposition explained how PCN Analysis could depict enabling and relieving innovations, but gave no indication about where the innovations came from. The present extension describes how an additional component of guided enumeration provides a more systematic approach to service innovation. In this section, we review general PCN Analysis concepts that subsequently will be used to identify and evaluate customer-interactive service innovations.

### *19.3.1 Process Regions and Relationships*

PCN Analysis focuses on the ways in which processes can be strategically designed to leverage interaction between firms and their customers. PCN stands for Process Chain Network. A *process chain* is a sequence of steps that accomplishes an identifiable purpose such as building a home, completing a tax return, or repairing a computer. The *network* is the set of entities that are involved in a particular process chain, making decisions about parts of the process. A *process entity* can be a manufacturer, a service provider, a customer, an agent of a customer, and so forth. Each process entity has a *process domain* that includes the set of activities that the entity has control over. An example of a process domain for an auto detailing business is shown in Fig. 19.1, called a *PCN Diagram*. Auto detailing, "is the performance of an extremely thorough cleaning, polishing and waxing of an automobile, both inside and out, to produce a show-quality level of detail" (Wikipedia). In Fig. 19.1, the detailing step is shown with three sub-steps: wash car exterior, clean car interior, and wax car exterior.

The activities in the process domain are organized into three *process regions*:

1. The *direct interaction* region includes process steps that involve person-to-person interaction between entities. For example, a detailing employee directly negotiates with employees of an equipment supplier in purchasing detailing equipment.
2. The *surrogate interaction* region includes process steps in which one process entity is acting on another entity's non-human resources such as their belongings, information, or technologies. When the employees are detailing the customer's car they are interacting with the car and not directly with the customer.
3. The *independent processing* region includes steps in which the entity is acting on resources owned and controlled by that same entity. Many of the processes of make-to-stock manufacturing fit in this region. In the Fig. 19.1 example the

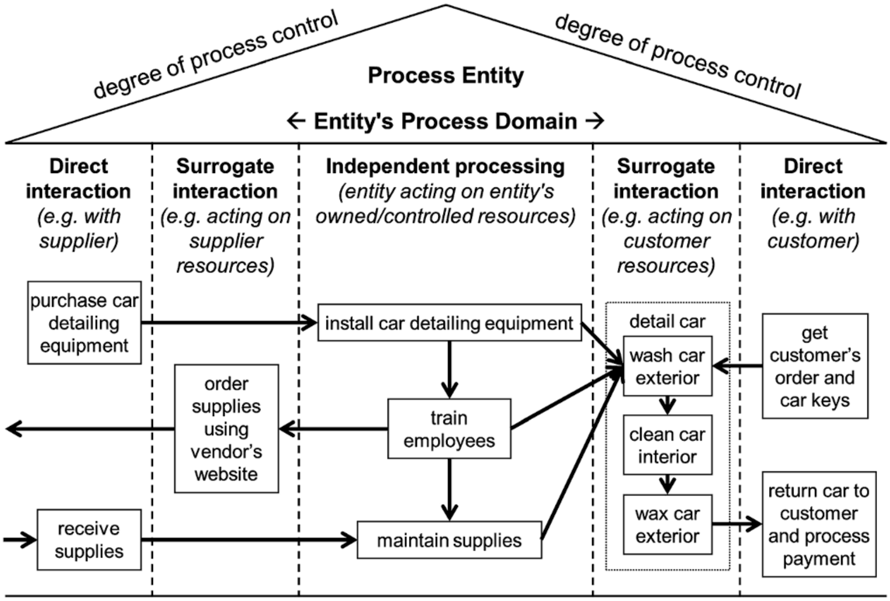


**Fig. 19.1** PCN Diagram for an auto detailing business

provider installs their own purchased car detailing equipment. If the equipment supplier installed the equipment it would instead be surrogate interaction.

There are important managerial distinctions between these three categories of process steps. Process entities have more control over independent processing steps than they do over surrogate or direct interactive steps, due to the need to give up some control in order to interact. The slanted "roof" on a PCN Diagram reminds us of those different levels of control.

## *19.3.2 Customer-Interactive Processes*

Since PCN Analysis considers networks of entities, it is more interesting to consider PCN Diagrams involving more than one entity. An important feature of PCN Analysis is not only understanding the provider firms' processes, but also understanding relevant customer and supplier processes that are part of the same process chain.

Figure 19.2 depicts how process entities involved in a given process chain can be linked together in a PCN Diagram. In that example, a focal firm interacts with a supplier and with customers. Note that this is different from a traditional supply-chain diagram, which typically have arrows to represent product flows from suppliers to customers. In a PCN Diagram the arrows represent the process sequence,

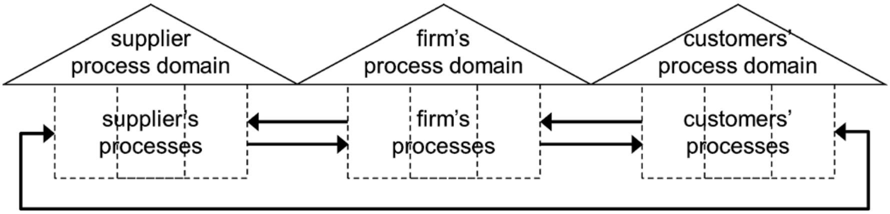


**Fig. 19.2** Network of entities

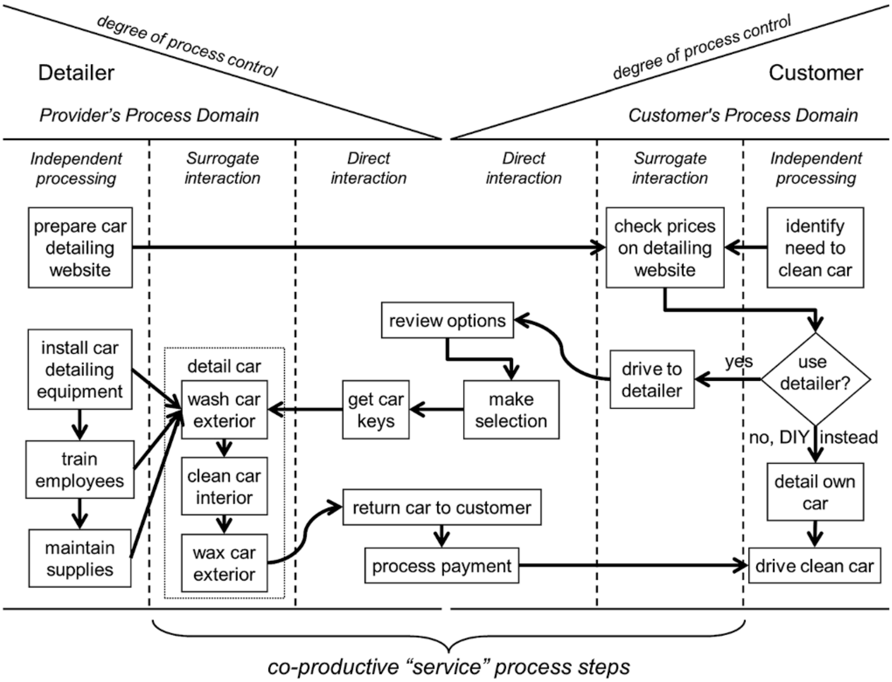


**Fig. 19.3** PCN Diagram for an auto detailer and a customer

which can progress in different directions between entities at different phases of interaction.

Service networks can be depicted in various levels of detail in PCN Diagrams. A dyad relationship can be depicted by showing part of process domains of two entities as illustrated by the Fig. 19.3 example. Figure 19.3 shows an auto detailing service provider on the left and a customer on the right, with only the adjacent regions of interaction being depicted. In this example, the customer independently identifies the need for having his or her car detailed. The customer might check prices on the detailing firm's website, which is surrogate interaction with the detailing firm. In this

example, the customers may independently choose to use the detailing firm or "do it yourself" (DIY) at home.

Figure 19.3 also delineates the steps that meet the "service" definition outlined above, with two (or more) entities *coproducing* a given value offering. This emphasizes that service exists in the regions of interaction between entities, and that there are different types of interactions. Next, we will look how these regions can be used in service design decisions that will lead to service innovation.

### *19.3.3 Strategic Process Positioning*

One aspect of PCN Analysis is "strategic process positioning" wherein specific portions of a process can be designed to deliver certain types of value or achieve desired operational characteristics. Process positioning is strategic in that it defines what type of business a firm is in and what value proposition the firm desires to provide to customers. For example, some firms assume a customer-accommodation strategy and other firms assume variance-reduction (standardized offering) strategy (Frei 2006). The functional strategies of a firm can be depicted in the process regions of a PCN Diagram.

Figure 19.4 shows five general regions of a two-entity (provider and customer) PCN Diagram. Regions #1 and #2 are in the provider's process domain, meaning that steps that fall in those regions are directly controlled by the provider. Regions #4 and #5 are in the customer's process domain, meaning that the customer directly controls those steps. Responsibility and control of steps in Region #3, direct interaction, are jointly shared between the provider and customer. Note that there can be different positioning of processes within Region #3, since some direct interaction is more controlled by the provider and some direct interaction is more controlled by the customer.

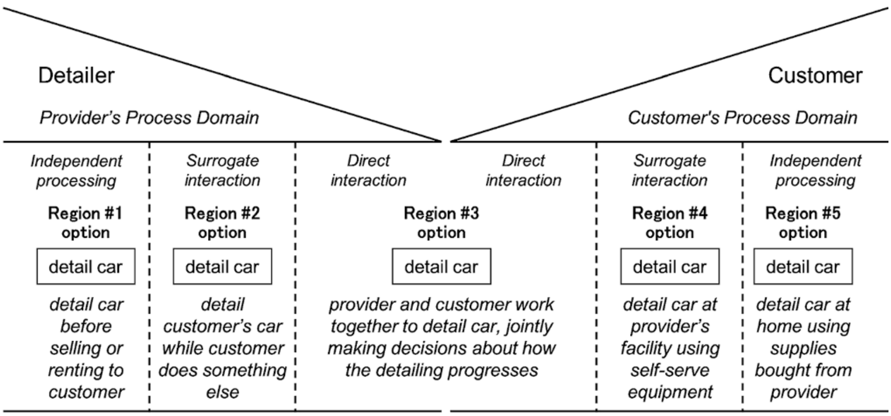


**Fig. 19.4** Process positioning options for the "detail car" step

Also note that every process step has these five options, although some options may not be practical or make sense in a given context. For example, Fig. 19.4 also depicts various options for the "detail car" step. The Region #1 option is for the provider to detail cars before delivering them to customers, which is what rental car firms usually do. The Region #2 option has the provider detail the customer's car without directly interacting for that step. Detailing a car through direct interaction (Region #3) means the customer and provider work together, which might provide some educational benefit (training the customer in how to detail a car). The Region #4 option might be a self-serve detailing that allows customers to use the specialized equipment of providers but also take control of the process step. The Region #5 option is for the customers to detail their cars just using resources they own, as was suggested in the DIY option from Fig. 19.3.

Other options might be depicted in a more complex PCN Diagram that involves more than two entities. For example, the detailing service provider might outsource some of the "detail car" sub-step to other providers, such as cleaning and conditioning leather upholstery. See (Sampson et al. 2015) for an example of PCN Diagrams involving multiple entities in a healthcare context.

### *19.3.4 Characteristics of Process Regions*

The search for service innovation will be guided by an understanding of the nature of process regions, including their operating characteristics and task requirements. This subsection reviews major managerial implications of each process region and points to related academic research streams. These implications are summarized in Fig. 19.5.

**Region #1 (provider's independent processing)** includes steps in which the provider acts independently from the customer and therefore has maximum process control—the provider can perform Region #1 steps when, where, and however desired. This is the region of make-to-stock manufacturing, where providers prepare goods in anticipation of subsequent demand, which of course has been studied in the extensive traditional operations management literature. It is the region of maximum economies of scale, making it ideally suited for process steps that require costly equipment or difficult-to-obtain expertise. It is also a region of high efficiency. Quality in this region is defined by planned or engineered specifications that are often tightly defined (Chase 1978).

**Region #2 (provider's surrogate interaction)** is what research literature calls the "back stage" of service delivery (Bitner et al. 2008; Herhausen et al. 2017; Zomerdijk and Voss 2010). Even though the customer is not physically present in Region #2, the customer's information or tangible belongings are available to be acted upon. Steps in Region #2 are beholden to customer demand, and therefore Region #2 has lower operating efficiency than Region #1 and also typically has lower capacity utilization, implying reduced economies of scale. However, Region #2 provides the opportunity for customization based on customer requirements.

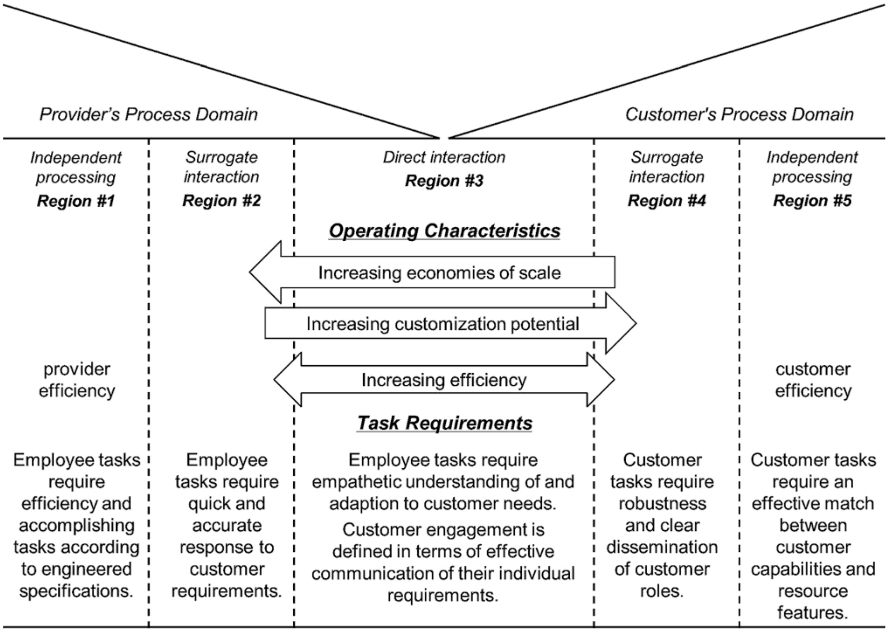


**Fig. 19.5** Operating characteristics and task requirements across the Regions

Performance of employees and systems operating in Region #2 tends to focus on speed and accuracy in responding to customer requirements, within the scope of the provider's offering.

**Region #3 (direct interaction)** is the "front stage" of service delivery, where customers and providers are actively engaged in coproduction (Teboul 2006). It does not require colocation, but does require simultaneity of interaction, such as through phone conversation. The intensity of interaction results in this being the region of lowest operating efficiency, at least vis-à-vis the other regions (Roels 2014). This region is described in the extensive "customer contact" and front-line employee literature (Kellogg and Chase 1995; Wirtz and Jerger 2016). The interaction in Region #3 allows for greater customization than Regions #1 and #2, but that customization can cause process variation and thus reduce economies of scale. Performance of employees engaged in Region #3 is typically based on the ability to ascertain and respond to customer needs in accordance with the providers value proposition. This of course is dependent upon customers adequately communicating their requirements and accepting limitations of the provider's offering.

**Region #4 (customer's surrogate interaction)** has the customer acting on provider resources. A typical example is so-called self-service, where customers are utilizing provider resources or, as the literature calls it, self-service technologies (SST) (Meuter et al. 2000). One tremendous advantage of operating in Region #4 is that customer labor is generally unpaid. In addition, customers now have the opportunity to control the process and customize as desired. However, the ability

to perform in this region is limited by the skills and motivation of each customer (Xia and Suri 2014), and customers, operating only on their own behalf, have low economies of scale. When customer skills and motivations vary, problems can arise (Frei 2006). Therefore, processes operating in Region #4 need to be sufficiently robust to avoid high costs of customer inadequacy (Chase and Stewart 1994). In addition, consideration must be taken to clearly disseminate customer roles, which is part of customer development (Xue and Harker 2002).

**Region #5 (customer's independent processing)** is where the customer has acquired all necessary resources and is attempting to realize value without further interaction with the provider. It is the region of do-it-yourself (DIY) where customers attempt to act on their own (Norton et al. 2014). The DIY literature is less developed than literature about other process regions. A benefit to the customer of processes in Region #5 is maximum ability to control the process, implying the opportunity for maximum customization. However, that customization may be limited by the customer's ability to perform the process steps, since the customer may have little experience and intellectual economies of scale. Still, the customer benefits from high efficiency, since at that part of the process the customer is no longer dependent upon the provider for interaction or resources. A key performance element in this region is that the features of the resources match the customer's capabilities and interests.

These operating characteristics and task requirements are summarized in Fig. 19.5. There we see increased economies of scale into the provider's process domain, increased customization potential into the customer's process domain, and increase efficiency away from the region of direct interaction. One redeeming benefit of the region of direct interaction is that it allows for a blend of both economies of scale, such as provider expertise, coupled with the customer's ability to influence the process for high customization. For that reason, services such healthcare, education, and counseling traditionally operate through direct interaction. Nevertheless, demands for efficiency are pressuring these and other industries to move out of direct interaction, which can be a ripe field for innovation.

### *19.3.5 Examples of Process Positioning Options*

As mentioned, every process step has these five process positioning options, although some options may not be feasible. We present a few examples as illustrations.

Figure 19.6 shows process positioning options for a step in a transportation process involving traveling to a destination. In Region #1 the traveler takes a subway, which operates independently from any customer. A bus is in Region #2, since the traveler can provide information—a stop request—that influences the way the service is delivered. The taxi service is in direct interaction, and is thus provides more customized travel than the subway or the bus. Alternatively, the traveler can rent a car and drive herself to the destination. Finally, the traveler could elect to drive

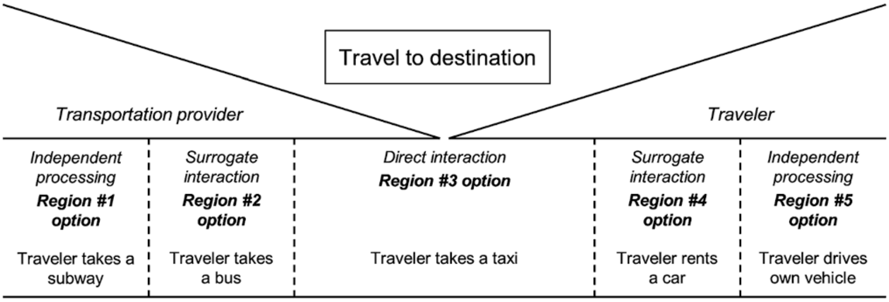


**Fig. 19.6** Transportation process positioning options

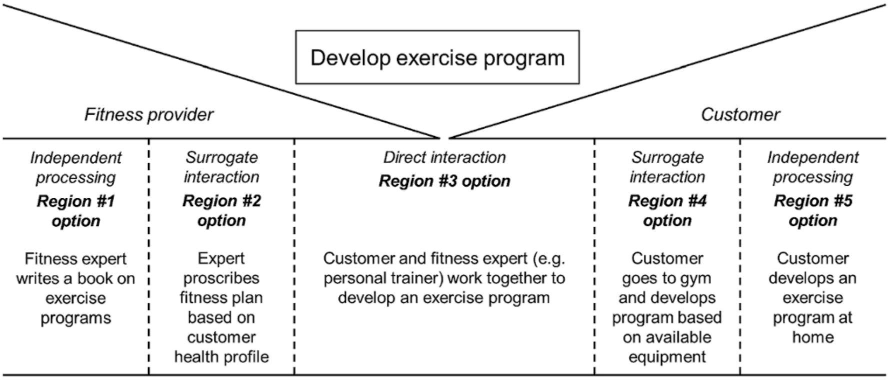


**Fig. 19.7** Exercise program process positioning options

her own vehicle, the DIY option. The Region #5 option provides the lowest utilization and economies of scale, but the highest customization. Innovative service such as Uber and Lyft have allowed car owners to also operate in Region #3, thus increasing utilization of their vehicle resource.

Figure 19.7 shows process positioning options for the process step of developing an exercise program. The program could be developed independently by the provider and documented in a book that could be distributed widely (high economies of scale). Or, an expert could develop a program based on information from each client. Personal trainers might collaborate with clients to develop an exercise program in direct interaction. The customer may go to a gym and use the gym's equipment to develop an exercise program. Or the customer could simply develop their own exercise program at home, using her own resources.

Figure 19.8 depicts process positioning options for an entertainment process of selecting music. Radio stations select music without any ongoing interaction with listeners. Services such as Pandora select music for listeners based on their expressed preferences (including thumbs-up and thumbs-down for specific songs). Live disc

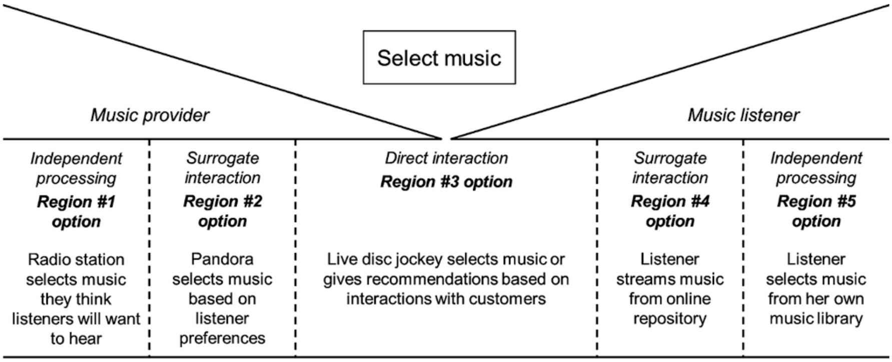


**Fig. 19.8** Music selection process positioning options

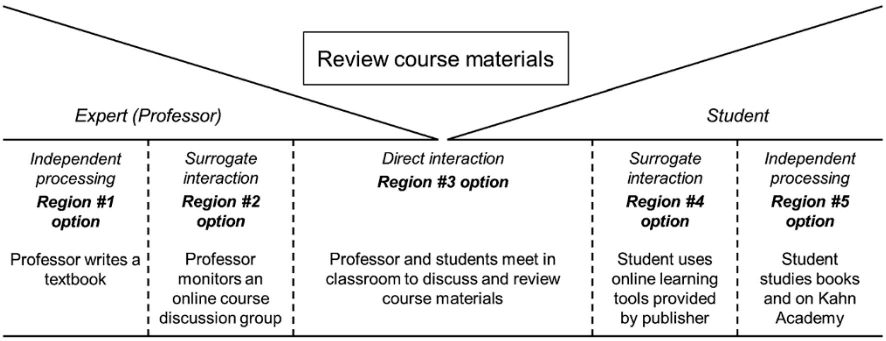


**Fig. 19.9** Education process positioning options

jockeys interact with listeners to select music tracks. Listeners can select their own music either from an online repository or from their own music library.

Finally, Fig. 19.9 shows process positioning options for an education process of reviewing course materials. The expert can review materials by writing a textbook. The expert can review materials based on student inquiries posted to an online discussion group. The professor and students can review materials in a traditional classroom setting. The student can use online teaching tools such as Pearson's MyOMLab, reviewing materials at her own pace. Or, the student can review the materials completely on her own using books or resources such as Kahn Academy.

These examples are simply illustrations of the application of process positioning. In each case, you will observe that the greatest economies of scale are in towards the providers process domain, the greatest customization potential is towards the customer's process domain, and the lowest efficiency is in the region of direct interaction.

## 19.4 Process Repositioning Innovations

In this section, we will describe how to explore service innovation by shifting steps of a process across process regions, which is the concept of strategic process positioning described above. A logical basis for process improvement is identifying customer needs and "pain points" (Furr and Alhlstrom 2011; Kahn 2012), since the satisfaction of needs is the basis for customer value (Buttle 2004). Customer needs are often expressed in psychological terms as an emotional construct, with a desired outcome of innovation being an improved emotional response (Dasu and Chase 2010).

In PCN Diagrams, we depict customer needs and psychological costs with ☹ symbols. We depict the satisfaction of needs, or psychological benefits, with ☺ symbols. The ☹ symbols represent opportunities for enhancing customer value (value being depicted by ☺ symbols). Of course, customer value is dependent upon the chosen customer segment, with different segments having different needs and values. We recognize that this emoji method of depicting customer sentiment is quite simplistic, yet it has been shown to be very effective in practical application.

As we analyze process improvement opportunities, it is important to consider the impact on the cost structure of the firm. In PCN Diagrams we depict monetary revenues with +\$ symbols and monetary costs with −\$ symbols. The combination of +\$ and −\$ symbols represent the profit value of the process configuration.

Returning to the auto detailing example, one customer pain point might be driving to the detailing service provider and having to wait (perhaps an hour or more) while the work is done, which might be especially costly for busy people. A second pain point might be reviewing the numerous detailing service options, since the customer may feel they are being up-sold to more expensive options. Figure 19.10 shows (in double-border boxes) how those two pain points (in dashed boxes) could be addressed. First, the "review options" step could be handled on a mobile phone app, giving the customer more control over that step and improving efficiency. In other words, the process step is moved into the customer's process domain. This type of service innovation is what Normann and Ramírez (1993) and Normann (2001) referred to as an *enabling innovation* because it enables the customer to meet his or her own needs with (in this example) reduced need for direct interaction.

The "drive to detailer" pain point in Fig. 19.10 can be addressed by providing an on-location detailing service that is handled at the customer's location—what Normann called a *relieving innovation* because it relieves customers of responsibility for the step. (We are assuming this can be done in ways that do not produce undesirable annoyance in locations where cars are detailed.) In other words, relieving innovations are accomplished by moving process steps from the customers' process domain to the provider's process domain. Providing the at-customer-location detailing service would increase the provider's costs (−\$) but could also provide increased revenue (+\$).

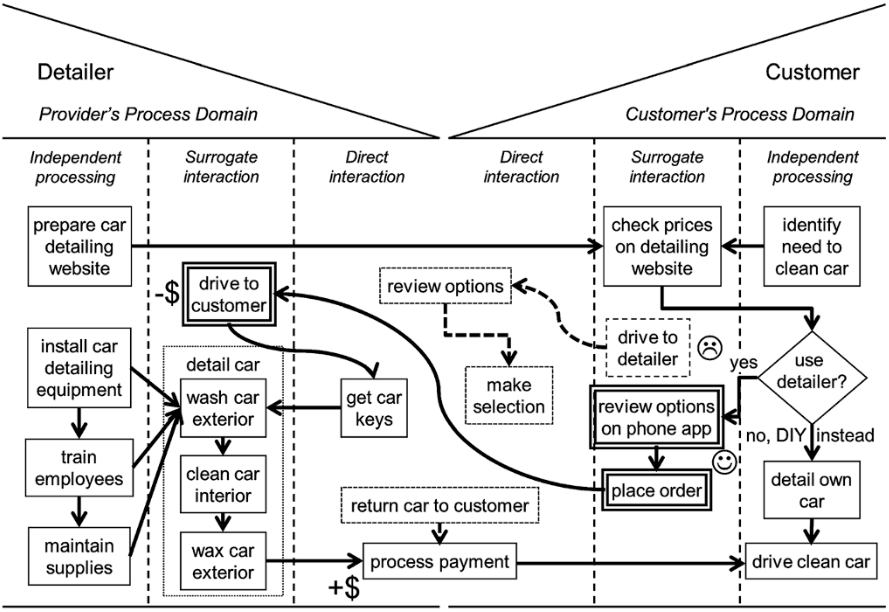


**Fig. 19.10** Service process value-improvement options

## 19.5 Discovering Innovation Through Enumeration

A particularly beneficial application of PCN Analysis is coming up with process innovation ideas. Unfortunately, service innovation is sometimes treated as an unconstrained brainstorming activity with few principles to guide the thought process, especially at the fuzzy front-end of idea development (Alam 2006; Montoya-Weiss and O'Driscoll 2000).

We can use the concept of strategic process positioning to identify service configuration alternatives with superior operating characteristics and value propositions. This section will describe a four-step approach to identifying and evaluating possible service innovations: (1) document the steps of a base process, (2) select steps to focus on for innovation exploration, (3) enumerate and interpreting procession positioning options, and (4) identify configurations that achieve desirable operating characteristics. This process will be illustrated with a pizza restaurant case study.

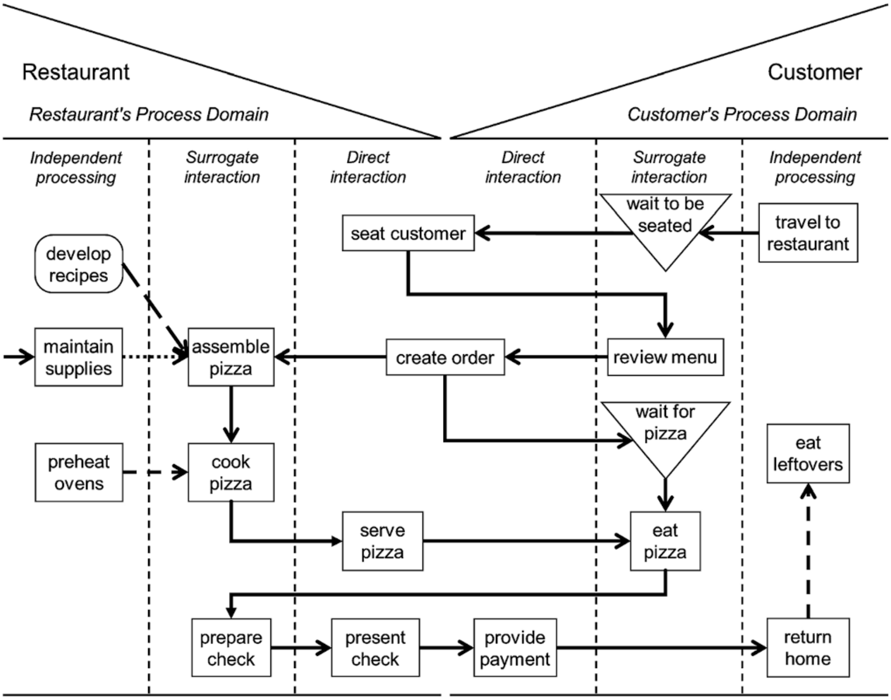


**Fig. 19.11** Sit-down pizza restaurant PCN Diagram

## 19.5.1 Document a Base Process

We begin by identifying fundamental process chain elements that are necessary to deliver a desired offering. This includes identifying steps that would be included in a basic PCN Diagram. For our case example, Fig. 19.11 shows a PCN Diagram for a pizza restaurant, which is one possible process configuration.

## 19.5.2 Select Focus Steps for Innovation

Selecting process steps as targets for innovation involves identifying possible pain points or opportunities to improve value. We will not go through the value assessment process, but it was discussed above. Frankly, the selection of process steps can be somewhat arbitrary; since some types of improvements might not be obvious it can be beneficial to explore alterations to various parts of the overall process. Nevertheless, tractability is aided by studying processes a piece at a time when looking for potential innovations.

For the pizza example, we may decide to look for innovation at the two steps involving meeting the customer's order: "assemble pizza" and "cook pizza." It may be determined that a target customer segment desires either less expensive pizzas (which would come through greater economies of scale), or more customized pizzas.

### 19.5.3 Enumerate and Interpret Process Positioning Options

The next step of structured process innovation is to enumerate other process configuration options as described in the Strategic Process Positioning section above, then subsequently interpreting what the options would mean in a practical sense. For our pizza restaurant example, Fig. 19.12 shows five different process configuration options for each of the two selected steps.

The pizza could be "made-to-stock" meaning the pizza firm makes the pizza without any interaction with customers or information from customers. Make-to-order pizza is assembled in the back office according to specifications provided by the customer. "Make together" means the customer and the provider's employee interact to accomplish the process step. "Make it yourself" has the customer assembling the pizza, in this case by using resources owned by the provider. The rightmost pizza assembly option is for the customer to make it at home using resources the customer previously acquired.

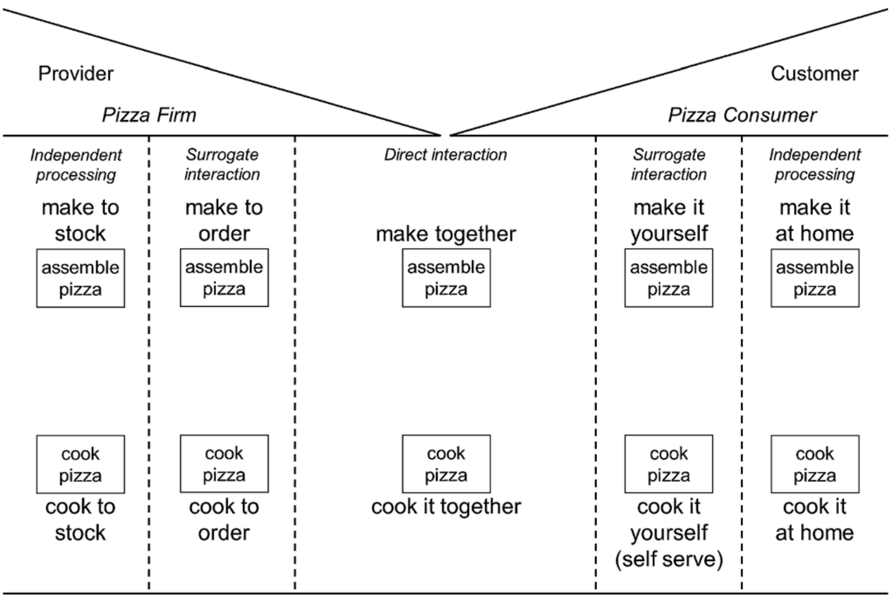


**Fig. 19.12** Pizza process step alternatives

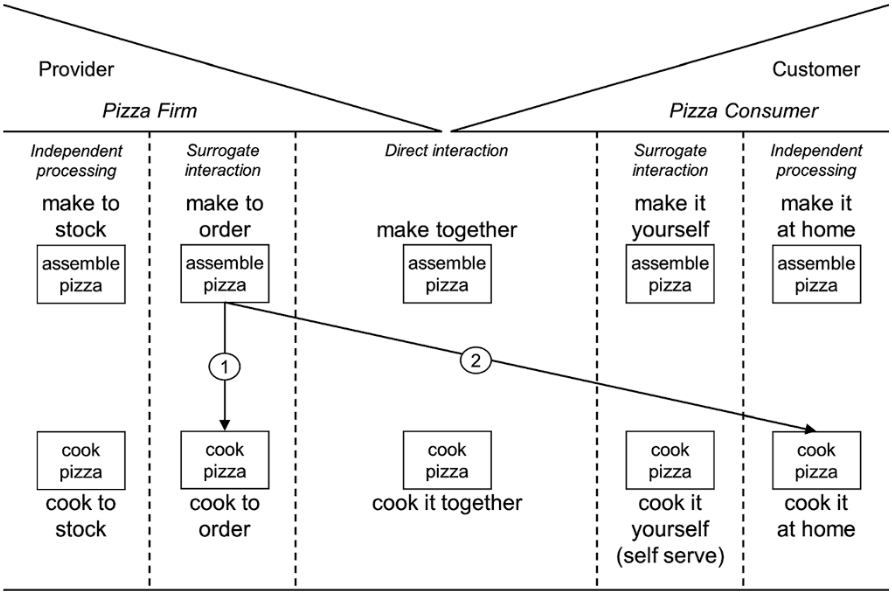


**Fig. 19.13** Two pizza process configurations

Figure 19.12 also shows process positioning options for the cook pizza step. Considering just these two steps, how many design configurations could be created? There are five options for assembling pizza and five alternatives for cooking pizza, suggesting that there may be as many as $5 \times 5 = 25$ configuration alternatives.

For example, Fig. 19.13 shows two configurations. Configuration (1) has the provider assembling the pizza to order and cooking it to order, which is the configuration used in the sit-down restaurant (Fig. 19.11) and is also used in a take-out pizza operation. That configuration provides a reasonable degree of customization—such as allowing the customer to select pizza options from a menu with personal tweaks like "hold the anchovies." There may be less customization in the cooking, other than differences for thin or thick crusts.

Configuration (2) is the take-and-bake pizza process in which the provider prepares the pizza according to the customer's order and delivers it to the customer, who is responsible for cooking it. This configuration allows the customer to have more customization about when and how to cook the pizza. The customer can cook the pizza at his or her convenience. The customer can cook the pizza in an oven, on a grill, or over the coals of a campfire. The pizza can be cooked lightly or well done. This cooking alternative provides the customer with more control over the cooking process, but supposes that the customer has sufficient knowledge, skills, and equipment to complete the step.

There are even more possible configurations, four of which are depicted in Fig. 19.14. Configuration (3) has the pizza assembled and cooked with no input from customers, as exemplified by the Little Caesar's Hot-n'-Ready® pizza, which at

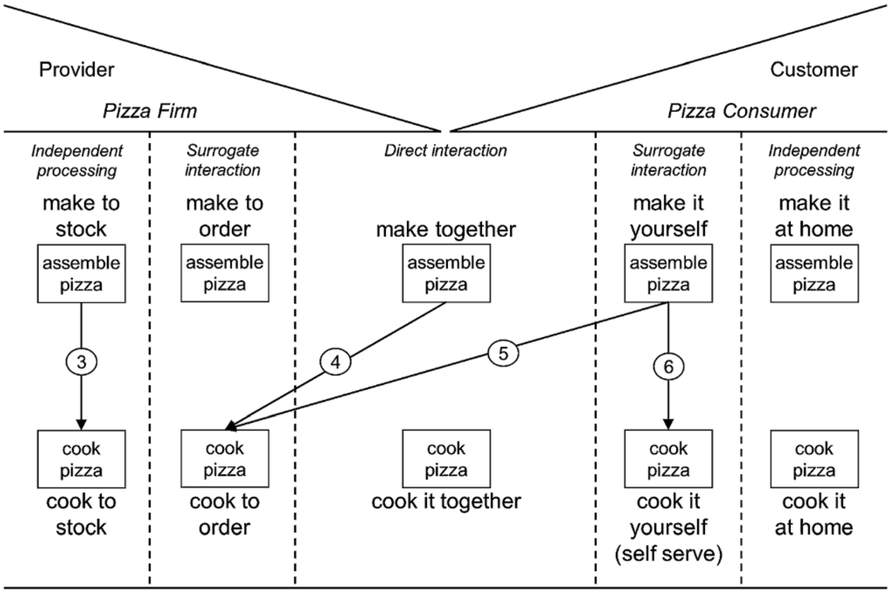


**Fig. 19.14** More pizza process configurations

this writing sells for a mere $5 for a large pepperoni pizza—emphasizing the economy of scale and corresponding cost benefit associated with independent production. Configuration (4) demonstrates a highly interactive option comparable to the Subway® Sandwich mode of operation (at various times Subway has also sold pizza). Current examples of configuration (4) are Pizza Studio and PizzaRev.

Configuration (5) is akin to a Mongolian barbeque, which gives customers the option of assembling their food from a bar of components, and then having it cooked by trained employees. In one sense, configuration (5) is superior to configuration (4) when customers have specific dietary requirements or are picky eaters, since customers have even more control over the "assemble pizza" step.

Configuration (6) may not be common for pizza offerings, but is common in Shabu Shabu restaurants in Asia. Shabu Shabu is a Japanese food that involves a small cauldron of hot water (over a gas burner) for each customer, and trays of vegetables, spices, and thinly sliced meats. This configuration is in the customer's process domain, implying tremendous opportunity for customization but also assuming the required process competency is sufficiently accessible to target customers.

Figure 19.15 shows a couple of additional pizza process configurations. Configuration (7) is the staple of poor college students: pizza from the grocer's freezer, such as the ever-popular DiGiorno or Red Baron brands. These frozen pizzas are produced through the epitome of mass production, with tremendous economies of scale.

Configuration (8) ensures provider efficiency by requiring the customers to assemble their own pizzas. In this case, the provider may sell pizza kits that contain

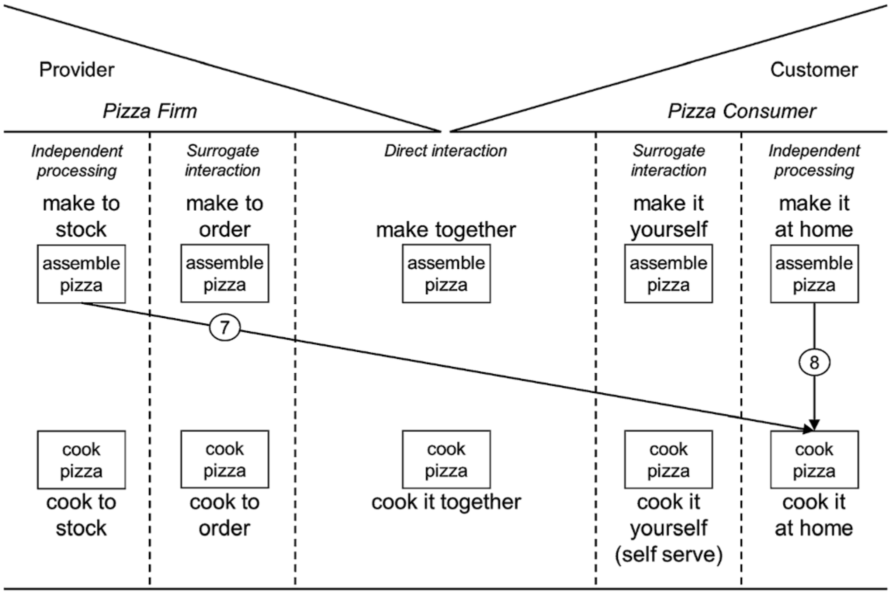


**Fig. 19.15** Even more pizza process configurations

typical components and assembly instructions. The Papa Murphy's pizza chain introduced "Mini-Murph™" pizza kits targeted at kids.

### *19.5.4 Identify Promising Innovation Configurations*

According to the process positioning principles described previously, configuration (7) is superior to configuration (8) in terms of economies of scale, but (8) is superior in customization. Having both operating characteristics in the same offering could be a tremendous innovation. An optimal process configuration should achieve different process characteristics at different points in the process, accommodating a customer segment's value requirements.

For the pizza example we may determine (such as through market research) that target customers value customization of pizza toppings, as well as control over where and when they eat their pizzas. However, that customer segment may be satisfied with a standard pizza crust, sauce, and mozzarella cheese. Our goal then would be to provide customization where it is valued (and can be recovered in price), and economies of scale where possible (to keep costs down).

Just such a configuration is shown in Fig. 19.16, which is an innovative pizza process that was initially designed by a team of undergraduate students (reprinted with their permission). These students had gone through the steps of reviewing an incumbent process configuration from which they might derive an innovative

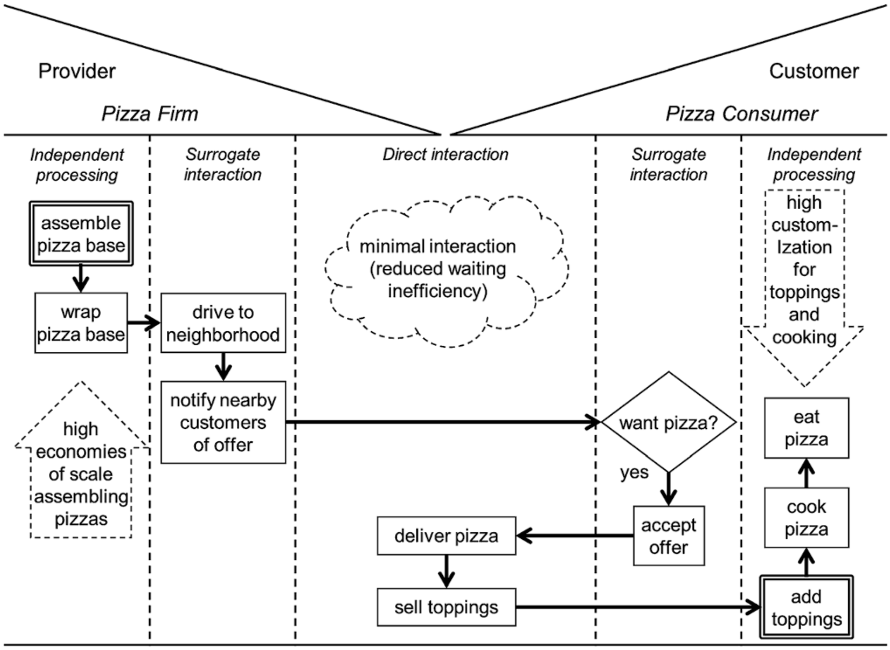


**Fig. 19.16** Innovative process configuration

improvement. Their target customer segment, as you might imagine, was undergraduate college students.

The idea was that the pizza provider would assemble the basis of pizzas (i.e., crust, sauce, and cheese) in a centralized location with common sets of toppings or no toppings at all. They would wrap the pizzas to keep them fresh for delivery. The firm, which already owned delivery vans, would then drive stacks of pizzas to select neighborhoods in the surrounding communities. A smartphone application controlled by the driver would notify the smartphones of subscribing customers in close proximity to the truck (or to where the truck was going), announcing (via an app or a text message): "a fresh pizza is two minutes away! Do you want it?" The subscriber could text reply or tap a pizza-shaped app button on their smartphone signaling their interest in the pizza. Within minutes, the driver would arrive at the customer's door, delivering the pizza and selling small packages of toppings (the instructor's idea). The customer would then add toppings as desired, cook the pizza, and then eat.

Operating characteristics of this innovation include the following:

- The "assemble pizza base" step is centrally located in the provider's process domain for maximum economies of scale. This is optimal because the customer segment does not require any customization of pizza crusts, sauce, and cheese.
- The "drive to neighborhood" step is surrogate interaction, being based on data about where pizza-eating students live and when they typically want to eat

(probably all the time). This allows for customization of delivery while maintaining some efficiencies.
- Customers are notified via technology—surrogate interaction for efficiency.
- Customers reply and accept the pizza offer via surrogate interaction for efficiency and control.
- The pizza is delivered to the customer and sold through interaction. In particular, the customer can see the available topping bags and get advice and specials from the delivery person.
- The “add toppings” step is moved to the customer’s process domain to allow maximum customization, such as placing toppings on only part of a pizza.
- The customer then cooks and eats the pizza fully within their process domain, for maximum customization.

## 19.6 Broader Applications of This approach

The above case example demonstrates how the principles of strategic process positioning can help us design and configure innovative service processes. In this chapter, we only considered innovation across a dyad, which is the simplest representation of a service relationship (Patricio et al. 2011). This innovation process can be extrapolated into innovations involving networks of entities, not just dyads. For example, one configuration option for the pizza restaurant might be to outsource pizza crust production to a manufacturer, providing even greater economies of scale. The crust manufacturer would be a third entity shown in the PCN Diagram.

The PCN Analysis techniques can easily be applied to service triads or more complex relationships involving multiple entities. For example, Sampson et al. (2015) demonstrate how to model service innovation in a healthcare situation involving patients, primary care physicians, medical specialists, transportation providers, and care coordinators.

Also, the PCN Analysis technique for innovation can be applied in various business contexts. Start-ups can use the technique to identify service delivery models that are distinct from what is offered by incumbent providers. Supply chain managers can use the technique to identify new ways to structure relationships with supply chain partners. Mature companies can use the technique to identify process reconfigurations that can be used to respond to evolving customer sophistication, such as due to the adoption of new mobile computing technologies.

## 19.7 Summary

This chapter described a systematic approach to service innovation using the PCN Analysis methodology known as strategic process positioning. We consider how steps of a process can be shifted across various process regions that have differing

operating characteristics and task requirement. Objectives of innovation might include increased economies of scale, increased efficiencies, or increased potential for customization. The attractiveness of each process region depends upon the value requirements of the target customer segment coupled with the operating requirements of the provider.

We reviewed the two types of interactive process innovations identified by Normann, *enabling innovations* and *relieving innovations*, and showed how they can be depicted on PCN Diagrams. Then we showed how new innovations can be discovered by process enumeration, guided by an understanding of the operating characteristics of each process region. We reviewed an example involving pizza production, and demonstrated that a variety of process alternatives exist. The same technique has been applied in numerous industries and contexts with insightful results.

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# Part III
# Service Ecosystems – On the Broad Context of Service

# Chapter 20
# Value-in-Context: An Exploration of the Context of Value and the Value of Context

**Melissa Archpru Akaka and Glenn Parry**

**Abstract** This chapter contributes to the advancement of service science by exploring the context of value and the value of context in service systems. The work advances theory development of value-in-context; a term initially introduced to conceptualize value within dynamic networks of actors interacting through exchange. More specifically, value-in-context emerged through the early development of service-dominant (S-D) logic and was an important part of the integration of S-D logic with service science. Recently, a service-ecosystems view has been introduced in the S-D logic literature, which has important implications for understanding value-in-context within service systems. The work presented here extends the contribution of S-D logic to service science by drawing on a service-ecosystems view and identifying various dimensions of value-in-context that shape evaluations of experience. More specifically, the chapter considers how phenomenological value is derived and determined within the context of a service (eco)system and offers a framework that conceptualizes value-in-context as a multidimensional construct.

**Keywords** Value-in-context · Service ecosystem · Service-dominant logic · Value co-creation

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_20

## 20.1 Introduction

Service-dominant (S-D) logic is a foundational framework for the study of value co-creation in service systems (Maglio and Spohrer 2008). In short, S-D logic is grounded in the idea that service—the application of competences for the benefit of another—is the basis of all exchange (Vargo and Lusch 2004). S-D logic's focus on what is described as value-in-use, or phenomenological value, as "real value" (Smith 1776) underpins the idea that value is always co-created in service systems because it is derived and determined by a service beneficiary (Vargo et al. 2008). Early conceptualizations of value co-creation in service systems also draw attention to the importance of context, or value-in-context, to highlight the contextual nature of value (Vargo et al. 2008). In the first volume of the *Handbook of Service Science*, Vargo et al. (2010, p. 147) made the connection between S-D logic and service systems by suggesting,

> "S-D logic's redirection of the focal point of value creation, away from a firm's output (and value-in-exchange) and towards the value uniquely derived and determined by an individual service system (e.g., customer – i.e., value-in-use), emphasizes a phenomenological and experiential conceptualization of value that has most recently been recognized in S-D logic as "value-in-context" (see Vargo et al. 2008). Value-in-context emphasizes the importance of time and place dimensions and network relationships as critical variables in the creation and determination of value."

Since the publication of the first *Handbook of Service Science,* advancements have been made to the conceptual framework of S-D logic, particularly pertaining to the conceptualizations of value and value co-creation. Thus, exploration and extension of the concept of value-in-context is important because although early work in S-D logic and service science recognizes the role of context in value co-creation, the nature of context and how it influences value was not extensively discussed.

Initial conceptualizations of contextual value center on networks of actors and differences across situations (e.g., time and place) that frame exchange (e.g., Vargo et al. 2008). Networks and situations are clearly important factors for individual actors when determining the value of a particular resource—i.e., resources have more or less value depending on the time, place and social network within which it is used. However, in 2011, Vargo and Lusch introduced the idea of a service ecosystem, which extends beyond situational and relational contexts and provides a lens for viewing multiple levels of interaction and value co-creation. The dynamic, multi-level perspective encourages researchers to "zoom out" to consider micro, meso and macro levels of context that impact value creation, and a meta layer that connects them all (Chandler and Vargo 2011).

Vargo and Lusch (2011) propose researchers adopt a service ecosystems perspective to emphasize the centrality of interactions and institutions that constitute the context through which value is derived. From this view, different levels of context are nested and evolving. The multiple-levels approach helps to reconcile various types of context (e.g., situational, social and cultural) by establishing a meta layer of

analysis that allows researchers to oscillate across different levels of interaction and understand diverse views on value.

A systemic view of value creation is especially helpful in conceptualizing how value is created in service systems—"dynamic value co-creation configurations of resources (people, technology, organizations, and shared information)" (Maglio and Spohrer 2008). 'Smart cities' are a type of service system that is emerging and evolving. Originally, the focus of Smart Cities was placed on the development of information communication technologies (ICT) and connectivity between parties within a city. The focus on ICT was a result of the point in history as the concept emerged concurrently with the development of the Internet. More recent work broadens the construct of a smart city to include investments in human and social capital, transport, sustainable economic growth, use of natural resources, participatory governance and ultimately improved quality of life for inhabitants (Caragliu et al. 2011). The vision of smart cities of the future includes a fusion of traditional infrastructures with digital technologies that provide a convergence of information to serve individuals, organizations, the systems of the city, and urban development (Batty et al. 2012). The service of a city will be enhanced through access to past data and real-time data that, through combination and analysis, informs decisions of individuals and organizations.

This chapter takes a closer look at the multiple levels of context that frame the co-creation of value and the impact context has on deriving and determining value within service systems in general, and smart cities in particular. First, we begin with an overview of a service-ecosystem lens for studying value co-creation and value-in-context. Second, we explore multiple levels of context that influence and are influenced by interaction and exchange. We "zoom out" (Vargo and Lusch 2011) using an example within a smart city, which extends from a specific value-creation situation to broader, social, cultural and historic perspectives. Third, we describe how context influences value, and propose a framework for considering multiple dimensions of value-in-context. We conclude with a discussion of the importance of understanding value as a multidimensional construct and highlight directions for future research.

## 20.2 A Service-Ecosystem View on Value

The intersection of S-D logic and service science establishes a service-centered, systems view on value. The concept of value-in-context emerged through the reconciliation of value-in-exchange and value-in-use, distinct meanings of value that have been discussed since the time of Aristotle (Vargo et al. 2008). On the one hand, value is considered a nominal measure of what a resource is worth, based on exchange i.e., value-in-exchange, and on the other hand, value is considered as an evaluation of a resource, based on how it is used i.e., value-in-use. S-D logic requires researchers engage with both nominal (value-in-exchange) and "real" (value-in-use)

forms of value (Smith 1776), and also give consideration to the context within which a resource is exchanged and applied (Vargo and Lusch 2004, 2008).

Vargo et al. (2008, p. 150) integrate the different forms of value through a systems perspective and argue "Value-in-exchange, therefore, provides a way of measuring relative value within a context of surrounding systems. . .value-in-use can be defined as system improvement within a particular environment (cf. Beinhocker 2006)". From this perspective, value is: (1) a nominal measure of worth, (2) the evaluation of an experience, and (3) an improvement to a system. This conceptualization of value indicates that value is multifaceted and difficult to define from a single perspective. Moreover, the concept of value-in-context suggests that any measure of value is dependent upon the context that frames a particular exchange, experience or change to a system.

Early conceptualizations of value-in-context focus on situational factors, such as time and place, and their influence on phenomenological views of value (Vargo et al. 2008). As the development of value-in-context concept continued, increasing attention was paid to the embeddedness of value in social networks and how social interactions and relationships influence value co-creation (e.g., Akaka and Chandler 2011; Chandler and Vargo 2011). Building on the network perspective, scholars began to recognize the importance of social practices and structures and how they frame evaluations of experience (e.g., Edvardsson et al. 2011; Vargo and Akaka 2012). Most recently, Vargo and Lusch (2011, 2016) propose a service-ecosystems perspective for conceptualizing value and value co-creation, and emphasize the role of institutions in value creation.

A service-ecosystem is "a relatively self-contained, self-adjusting system of resource integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo and Lusch 2016, pp. 10–11). This view of value co-creation and value-in-context underscores the multidimensional nature of social networks and importance of institutions in value creation. Institutions and institutional arrangements (Vargo and Lusch 2016) have been recognized as central to value-in-social-context (e.g., Chandler and Vargo 2011; Edvardsson et al. 2011), as well as value-in-cultural-context (e.g., Akaka et al. 2013, 2015). Cultural views on value consider the importance of social interactions and social structure, but also highlight the influence of signs and symbols in value creation (e.g., Akaka et al. 2014; Venkatesh et al. 2006). The consideration of social and cultural contexts suggests that as individual actors (e.g., people or organizations) interact and engage in exchange with others they are simultaneously contributing to the creation of value for themselves and continually reshaping the social structure (e.g., market) and culture within which value is derived.

One of the distinguishing features of a service ecosystem perspective, which can extend research on service systems, is the emphasis on micro, meso and macro levels of interaction, which are nested and continually evolving (Chandler and Vargo 2011). It is important to note that these "levels" of interaction are not fixed or mutually exclusive. Rather, the multiple levels of context and value co-creation can be conceptualized as aggregations of interactions, which can be viewed from

various perspectives—e.g., dyadic encounters to networks of value co-creation. To understand the relationships across the different levels of interaction, a service ecosystem perspective offers a meta layer of analysis, which enables researchers to move between the micro, meso and macro and gain a more comprehensive understanding of value and how it is jointly created (Chandler and Vargo 2011). A multi-level view of interaction and value co-creation draws attention to the complexity of context that frames value creation and exchange (Akaka et al. 2013).

## 20.3 The Context of Value

An S-D logic, service-ecosystems perspective emphasizes the contextual nature of value. From this viewpoint, understanding the context of value is central to understanding value itself. In this section we "zoom out" from "micro" to "macro" perspectives to consider different views of context that frame phenomenological evaluations of value. We begin with an exchange context, or service encounter, as this has been recognized as a micro-level point of value co-creation within a service ecosystem (e.g., Akaka et al. 2015). We then zoom out to broader contexts of value and how each context might frame a particular service encounter to reveal deeper insights into what value is and how it is co-created.

To illustrate the different levels of context and how they are related, we situate our service encounter within the context of a smart city. More specifically, we focus on urban transportation and how multiple levels of context frame value co-creation. We use this example because urban transport is a challenge for all major cities and the problems faced are accretive, from micro-level transportation decisions made by an individual to meso-level perspectives of transport providers, through to a macro level of visible congestion and air pollution leading to potential changes in urban planning. This is a central concern for the development of smart cities.

In the following sections, we discuss particular types of context to highlight how evaluations of value emerge and are influenced by a variety of settings. Through the descriptions of each type of context, we provide a running example of urban transportation in a smart city to explicate the importance of zooming out, which elaborates the context of value and provides insight into the value of context.

### *20.3.1 Exchange Context*

The study of value co-creation began with discussions of co-creating customer experiences. In particular, Prahalad and Ramaswamy (2004) argue that experiences emerge through the interactions of customers and firms and their efforts to create value by engaging in exchange. Specific points of customer engagement with firms have been recognized as "service encounters." Surprenant and Solomon (1987, p. 87) describe a service encounter as "a dyadic interaction between a customer

and a service provider," which is influenced by expectations, and for which value is measured by the level of customer satisfaction. Early on, the study of service encounters focused on the roles of firms and customers in time and place specific settings, meaning that they are finite and generally short lived (Solomon et al. 1985). Work has been done to extend the scope of a service encounter and incorporate the emotional responses of customers across multiple phases—peripheral, core and post-core (Walker 1995), as well as the impact of other people in these specific spaces (Davies et al. 1999). The focus of this context, however, is the direct interaction between a customer and service provider, which is centered on exchange.

Service exchange encounters are prevalent in transportation, a critical aspect of survival in modern times. Urban transportation enables us to travel to work, engage with others, and access necessary resources, such as food and shelter. One of the central needs for transportation is to travel to and from work on a daily basis. If we examine one person's journey to work, there are many options for engaging in exchange, and each requires the sacrifice of certain resources and tradeoffs. The individual must decide on which resources to access, then engage in exchange to 'buy' access to those resources before interacting with a service provider, sometimes multiple times, throughout a customer journey. In London, for example, there is an underground train network, known as the 'tube,' which has an iconic map that clearly shows the routes, but is in fact inaccurate with regards geography; in some cases, it is quicker to walk between stations. Taxi, bus, cycling or boats are also viable options as part of certain routes. The decision of the individual is dependent on numerous factors: the requirement to arrive at a certain time which links to the individual's ability to pay; ability to walk or cycle (e.g., are they impaired with injury, illness or carrying bags?); the current availability of different transport resource; the status of the network and predicted journey times that includes information of possible delays, breakdowns etc.; and as this example is England, the weather.

In this case, situational factors, such as distance and time and exchange factors such as financial limitations might influence a person to use the 'tube' to get to and from work each day. A need to arrive at a specific location quickly might mean a taxi or *Uber* is selected. Additional factors such as the weather, safety and costs of alternatives may also influence value creation from this view, and all are part of the context of value and value co-creation. In the development of a smart city, for example, journey planning could be initiated by stating a desired outcome. A decision on which transport option to take is guided by analysis based on real-time data of state of the system, an evaluation of tradeoffs leading to journey optimization. In considering the process of value co-creation we can begin with a service encounter and explore the journey and apply an analytical meta layer to work across micro, meso and macro levels of analysis.

### 20.3.2 Social Context

The study of value-in-context has drawn attention to social aspects of context that frame value creation and exchange (Chandler and Vargo 2011; Edvardsson et al. 2011). Chandler and Vargo (2011) focus on the complexity of social networks that influence value co-creation. They explicate a multi-level framework for conceptualizing context, which includes micro, meso and macro levels of interaction and value creation. They elaborate the embeddedness of these levels and propose the idea of a meta layer for analyzing how value is co-created occur across different levels (e.g., micro to meso) of interaction and institutions. In other words, the service ecosystem is constituted by micro-level dyads, meso-level triads and macro-level networks, which are bound by a meta layer of interconnected interactions (Chandler and Vargo 2011). The level structure enables researchers to oscillate across the different levels and study value and value co-creation from various perspectives. Taking a slightly different approach to social context, Edvardsson et al. (2011) draw attention to the way context is socially constructed through practices and the formation and reformation of social structures. Together, both networks of actors and the social norms and meanings that guide interaction are central to the co-creation of value and the (re)formation of markets (Akaka et al. 2015).

Zooming out in the example of urban transportation, an exchange decision and service encounter may not be solely influenced by cost effectiveness and convenience. The decision to ride (or not to ride) a train also may be influenced by specific relationships or broader social norms. For example, if a person has a friend or friends who ride(s) the tube at the same time to the same places he/she might see this as an opportunity to socialize and build relationships. In addition, socio-environmental concern may give rise to a perceived pressure or desire for walking or cycling, which also may be encouraged and/or socially rewarded. In the London example, a congestion charging zone exists within the city. The charge aims to reduce congestion and thus emissions in order to improve air quality by placing financial burden on those wishing to drive within the city. In concert, the city has encouraged cycling, making riding to work socially rewarded and more popular.

Thus, by considering the social context that frames the service encounter of making a decision to take train or ride a bicycle to work, attention is drawn to additional variables that may influence the co-creation and evaluation of value, i.e., value-in-context. In this case, direct or indirect relationships with others may impact a person's choice for exchange and may also influence the value derived through a particular experience, e.g., a person might feel good about taking the bicycle because it is popular and she is joining with others to help protect the environment.

### 20.3.3 Socio-Technological Context

Value-in-context is enhanced through socio-technical system development. The Internet-of-Things (IoT) describes a variety of technologies that enable objects to be identified, send information or be operated via the Internet. IoT provides the global architecture that enhances intelligence and facilitates provision and exchange of goods and services (Weber and Weber 2010). The infrastructure is in a state of constant development and should, not yet, be considered as a universal, stable or universally available entity (Dourish and Bell 2011). In addition to social influences, technological aspects of context are important for understanding value, because technology is one of the main contributors to value co-creation in service systems (Maglio and Spohrer 2008).

The value of such socio-technical systems for an individual is grounded in the ability for transfer of information through technology. For example, the IoT captures, collects and provides contextual data for both current and future scenarios. Data is a central driver of individual decision-making. Thus, the IoT gives individuals access to data across particular situational contexts and provides insight into how they may enhance their use of resources to create value in a particular context. As an example, data on multiple firms' offerings combined with data on the individuals' specific use of those offerings in context would inform their purchase or contract renewal decisions.

For the individual in our example, she may be able to track how much time, on average, is spent in transit and accommodate for that time by selecting specific music for entertainment. Furthermore, she may be able to share geographic information for friends or family members who are interested in this information. For transport providers, understanding of value-in-context is enhanced through the collection of data from the specific point of use. Here the IoT and other systems can give details of how the individual is creating value whilst enmeshed as part of the human/technical system in which their offer is embedded. Visibility of consumer use (Parry et al. 2016) of multiple resources in context provides many possibilities for providers.

A future smart city may also provide access to aggregated data and analysis that includes pedestrian flow levels and 'cross traffic' (Wang et al. 2016). Research has linked data with measurement of air quality, and also measurement of stress experienced by individuals as part of their journey (Zeile et al. 2016). Such data linkage allows for the design of offers for a specific individual in a particular context and facilitates alerts that enable a firm to respond to urgent need. Empirical data would provide organization's both large and small with evidence for investment decisions. Continuing our travel example, a town council may have visibility of all its assets in use e.g. traffic lights, rail, roads, street lights, bus services etc. For employers, the employees would be more likely to arrive on time, boosting productivity. Firms may further be helped by technology to find greater efficiency in travelling to client meetings. Individuals could collect data on previous journeys and share that with others to help improve analysis and optimization. Allowing data to be shared across the levels of aggregation means the smart city can integrate data and undertake

analysis to optimize individual, firm, organizational or societal goals. When such analysis is undertaken, tensions will arise between competing demands. For example, an individual may desire speed and opt for a taxi, but social or regulatory pressures for clean air and reduced congestion may suggest cycling. It often becomes a question of policy and governance how prescriptive such systems become.

### *20.3.4 Cultural Context*

Cultural context builds on the notion of social context (Edvardsson et al. 2011) and considers the sign systems and related symbols that frame value creation and exchange (Venkatesh et al. 2006). This context provides a broader backdrop for exchange then social and socio-technical lenses because it highlights the cosmological principles that influence meaning (Penaloza and Mish 2011). Importantly, the cultural context framework can be scalable to any level of interaction and is not only a global-level perspective (Akaka et al. 2013b). Arnould and Thompson (2005, p. 869) discuss the nature of consumer cultures and conceptualize "culture as the very fabric of experience, meaning and action." Extending this view of culture beyond a consumption perspective, Akaka et al. (2015, p. 270) conceptualize cultural context as "a collection of practices, resources, norms and meanings that frame the co-creation of value and guide the evaluation of an experience." This definition includes components of the social context described above, but also considers the impact of cosmological principles and symbol systems as well (Penaloza and Mish 2011).

Extending beyond the exchange/situational, social and socio-technical views, cultural contexts reveal structures of common difference that enable one group to be distinguished from another (Wilk 1995). For example, whereas riding a bicycle is common practice in a city like Amsterdam—cycling is a 'cultural norm', taking a tube train is common in London, and driving in a car may be the most popular mode of transportation in Los Angeles. While these practices are impacted by the infrastructure and the technological aspects of context, it is also important to note that social norms are a powerful driver of human behavior and cultural differences across different groups of people indicate that just because you build it, does not mean they will pay for and/or use it.

The consideration of cultural context is a particularly important notion in the development of 'smart cities.' This is because, using new technologies often require cultural shifts that relate to widespread understandings of how people live out their daily lives. For example, cultural norms may lead people to be sensitive to privacy issues when it comes to capturing and collecting personal data. In some cultural contexts, privacy may not be as big of a concern as in others. This, of course, is related to social norms of enabling companies to track different patterns of behavior, but is also tied to cultural meanings of privacy and security. Thus, from a cultural context view, developers of smart cities need to consider how best to offer improved service efficiency, while creating value for communities. Technology allows for

accretive datasets through low cost interaction with individuals, which together creates 'big data.' Although society would benefit from optimization of journeys within a city through enhanced productivity and potentially lower emissions, the co-creation of value will also depend on how people perceive the relationship between data and privacy. In addition, it is important to note that culture is continually in flux. Thus, the influence of a particular cultural context can change over time, giving rise to observable changes across the micro, meso, and macro levels, and lead to systems change.

### *20.3.5 Historical Context*

The historical context of value is essential for understanding how socio-technological and cultural contexts change over time and how views on value evolve. It is clear that technology and information have long influenced service transportation decisions. For example, in twelfth century London individual public transport was river based, with rowing boats transporting passengers between the slipways, which are recorded in the Domesday Book of 1086. Value for the customer emerged through service offering efficient and safe passage on the river undertaken by a Thames Waterman, whose knowledge was recognized through their membership of a guild, 'The Company of Watermen and Lightermen', as well as regulated fees. For organizations, worth was supported through the social recognition of the value of their knowledge and practice. This ecosystem of rowing boats and skilled oarsmen evolved over time. A seventeenth century technological revolution, in the form of the horse and carriage and improvements in bridge building, effectively ended the water taxi ecosystem. In turn, the horse and carriage was displaced in 1903 when new technology, such as the combustion engine, powered taxis and buses, were introduced. Combustion engines remain dominant today, though electric hybrid vehicles are increasingly being employed. It's important to note that although change occurred over time, innovation is not a linear process (Kline 1985). Market feedback loops on which types of transportation would replace others reveal how some types of transportation remained constant while others evolved.

What had remained relatively unchanged since the twelfth century was the value created as a result of the watermen/driver's knowledge of the best routes to take between locations in given conditions. The practice of skilled individual transporting passenger is reproduced and institutionalized, so whilst the technology has changed, the practices at appear similar. Today, London Black Cabs drivers require a 3-year apprenticeship to learn 'The Knowledge' of routes and the possible alternatives when congestion is bad. Further, in black cabs, as in many other taxi services, the customer does not know the final price until the journey is complete, and price is dependent on journey time, distance, time of day and number of people being transported. Knowledge is held within the provider network which ensures standards and creates barriers to market entry thus enabling higher pricing which enables drivers to earn a fair living from their knowledge (Beesley 1973).

This brief illustration of a historic context of transportation draws attention to how value emerges through the development and evolution of a service system. More specifically, transport decisions are made by individuals at a micro level, and mechanisms of value capture protected by organizations at a meso-level. However, disruptive innovation at a meso level are influencing the value creation systems at a macro level, as well as a micro level, as social and cultural contexts of the transportation industry has changed dramatically in recent years (Wood et al. 2017). New market entrants to the taxi/minicab business such as Uber and Lyft utilize new technologies, which create platforms that integrate driver with customers and utilize macro level data sets that map the transport network and employ routing algorithms that dynamically adapt to congestion and inform drivers accordingly. Thus, this historical context provides insight into how situational exchange contexts might vary across time and space. In addition, social and socio-technological aspects of context are also clearly connected with situational and exchange contexts as these new technologies and social norms influence individual choices of transportation and value creation.

From a smart city perspective, data can be captured across various service encounters and throughout a customer's experience journey. For example, data collected on the location of vehicles and the price of the journey can be shared with the customer as well as the organizations providing various services. Data therefore informs the value decisions of both the firm (e.g., driver) and customer. Over time, value may also accrue at a societal level, for the city in this case, through reduced congestion and lowered air pollution. This historical view indicates that system value optimization may be achieved through ride sharing, and scenario modeling in New York City suggests that if customers share rides there are fewer journeys, time is saved as there is less congestion, and emissions are lowered (Ota et al. 2015). By considering the past, the present and the future, designers of smart cities can help create better options to optimize value co-creation for a variety of current and future citizens.

These overviews of different "types" of context enable the reader to zoom out from a specific exchange context or service encounter to understand the social, technological, cultural and historical variables that can potentially influence value co-creation and the evaluation of a particular experience. Figure 20.1 illustrates how micro, meso, and macro levels of context (Chandler and Vargo 2011) constitute value-in-context.

Whereas the different surfaces indicate that contexts can be considered from various levels of analysis, the vertical lines represent a meta-layer that enables researchers conceptualize the embeddedness across the levels of context and draws attention to how interaction across the three levels propels systems change. Although this figure depicts the existence of multiple levels of context, it does not does not fully reflect how value emerges and is evaluated within a particular context. This is discussed in the section that follows.

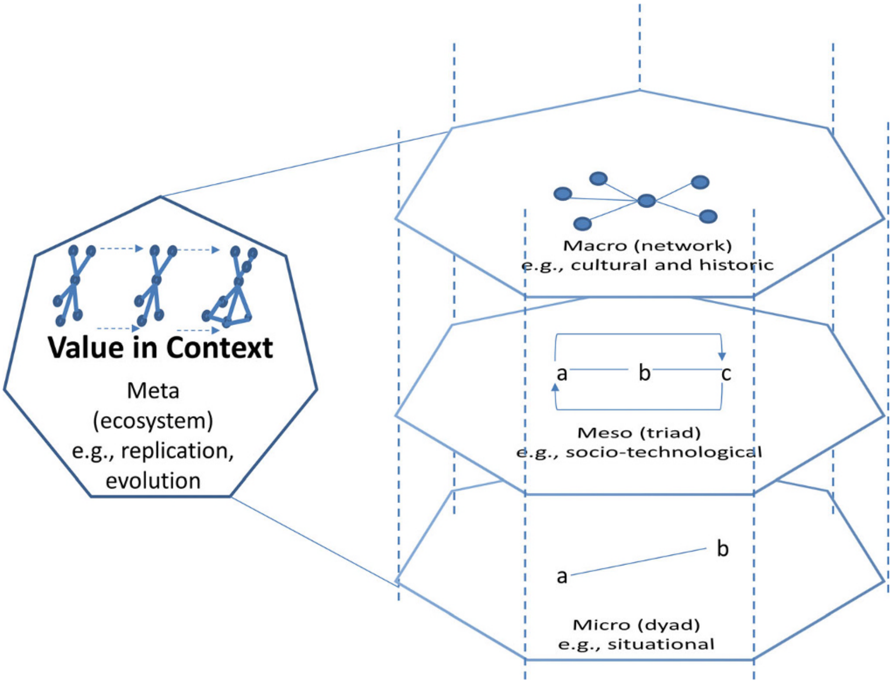


**Fig. 20.1** Levels of context

## 20.4 The Value of Context

The preceding section provides a framework for conceptualizing multiple and embedded levels of the context of value, which is based on a service-ecosystems perspective (Vargo and Lusch 2011, 2016). This next section discusses the value that emerges through exchange, social, socio-technological, cultural and historical contexts. We continue to draw on an S-D logic, service-ecosystem view, which highlights the phenomenological nature of value, within a dynamic systems perspective. In this view, context influences phenomenological value by framing our 'lived experiences' (Thompson et al. 1990). This contextual and phenomenological view on value suggests the study of value can be explored through various entry points of context (e.g., situational or historic), but always rely on evaluations of experience that may vary throughout a service system.

### *20.4.1 Phenomenological Value*

From the onset, S-D logic promoted a shift in focus from value-in-exchange and towards value-in-use (Vargo and Lusch 2004, 2008). This shift toward use value is

premised on the application of a resource in a specified context. That is, value is not created through a "production" process; rather, value is derived through the use of an offering and phenomenologically determined by a service beneficiary. From this viewpoint, value is phenomenological because it relies on the perspective of a service beneficiary and is determined in a particular context. Importantly, Vargo and Lusch (2004) argue it is not the resource itself that is of value, but rather the service that a resource can render (Penrose 1959), as 'resources are not they become' (Zimmermann 1951), which is to say a resource only becomes useful when employed. Along these lines, a phenomenological view of value centers on the evaluation of a micro-level experience at a particular time and place, and by a specific actor. However, as noted above, value is also influenced by other levels and wider contextual frames i.e., social, technological, cultural and historical.

Phenomenological or experiential value implies that value is not embedded in a given object (Ng and Smith 2012). Rather, value emerges as an artifact becomes a resource through value-creation processes (Zimmermann 1951). Value co-creation suggests that value is created through the integration of resources and interaction across multiple actors, but is always determined by a specific beneficiary. Phenomenological experience value [PE Value], as it is named by Ng and Smith (2012), is conceived in the experience of objects for purpose by the user. Thus, an object's meaning is reconstituted during an individual's experiencing of that object as she integrates it into their system during use (Laverty 2003; Husserl 1939). Along a similar vein, Heidegger argues that the capture of direct experience, is not possible as description is interpretation and the process of interpretation requires the individual undertakes reflection (Heidegger 1962). Understanding is necessarily embedded in, and shaped by, a person's history. Individuals draw on their past during reflection as the pre-understanding and prejudice developed from previous experiences provide the frameworks that enable them to make sense of their world (Gadamer 2004).

As frameworks of understanding, language used, and prejudices developed are dynamic, so too is the phenomenological experience value ascribed to service in context. Phenomenological experience value is an interpretation of experiential value expressed at a point in time and based upon an individual's knowledge and experience. However, value perception is influenced by broader social, technological and cultural contexts and is open to change. The historical aspect of context is equally as important as others because as time passes, context changes; the moment of natural existence is forever lost. Expressions of experience of phenomenological value are at the apex of past/present/future and are shaped by and in turn may shape context. Reflecting back on any experience is undertaken from a different point in time and new context, which necessarily shapes the perception of the observer. Thus, what is perceived as the truth of historical experience is actually only a perception based upon a different context. In other words, phenomenological value of a particular experience or service encounter changes as an individual reflects and re-reflects on that instance. Thus, context at the time of the reflection, or evaluation of value, is equally as critical for value co-creation as the context at the encounter itself.

We can see this played out in online reviews that give insight to individuals experience. Whilst notionally the reviews would reflect the individuals experience of the micro-level transaction, such as the train journey. However, their reflection of a 'good' journey may later change if they hear others were faster or cheaper, changing the phenomenological value.

### *20.4.2 Dimensions of Value-in-Context*

Conceptualizing phenomenological value as a 'lived experience' requires the consideration of multiple levels of context, as discussed above. Each level of context frames any given experience. However, focusing on different levels of context that frame value creation (Chandler and Vargo 2011) can draw attention to different types of value (Penaloza and Mish 2011). In particular, Penaloza and Mish (2011) discuss three levels of value, which align with micro, meso and macro levels of value co-creation—experiential value (micro level), social norms and values (meso level), and cosmological principles and meanings (macro level). These different types of value are related to phenomenological value, but meso (values) and macro (meanings) levels of value align more closely with social and cultural contexts, respectively. In other words, the meso and macro levels of value (i.e., social norms and meanings, respectively) also constitute the context through which phenomenological, or experiential, value are derived and determined (i.e., social and cultural contexts). Given the apparent alignment, we propose that a focus on phenomenological value (Vargo and Lusch 2008) and how it emerges through multiple levels of context brings together various viewpoints and increases parsimony in studying contextual value. Based on this, we identify several dimensions of value-in-context, which are influenced by the embedded levels of context discussed above.

The multiple dimensions for conceptualizing value-in-context together constitute the meta layer of analysis (Chandler and Vargo 2011) that brings together the different levels of context into a comprehensive understanding of value. The meta layer is difficult to conceptualize and even more challenging to study as it cuts across multiple levels of analysis, which often require different methodological tools to measure. However, it is important because without cutting across the different levels of context over time it is difficult, if not impossible, to develop a holistic understanding of contextual value. Figure 20.2 illustrates how the meta layer helps to flatten different levels of context and how each level of context influences value determination depending on the contextual lens used.

In the case of urban transportation, to understand phenomenological value in the context of exchange, or during the service encounter, would require a focus on the direct interaction between a customer and an organization. In this situation, the 'lived experience' could be evaluated during the direct interaction between customer and provider, or while a person is going through a particular customer experience journey, such as deciding to purchase a ticket or a pass, making the purchase, riding the train, exiting the train, and arriving at their destination (see, for example Berry

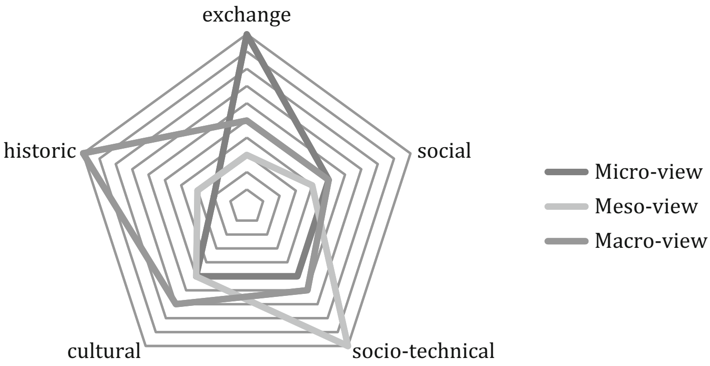


**Fig. 20.2** The meta layer of value-in-context

et al. 2002). However, focusing on the evaluation of an experience at this level places the specific exchange or service experience at the forefront of the emergence of value-in-context. Thus, the additional dimensions of context are distanced from evaluation and, perhaps, measurement of this view of value. For example, social contexts such as networks of relationships and overarching norms for social desirability (e.g., ecological ideals) are less influential than the timeliness and cleanliness of the train and the immediate situational surroundings. Thus, the direct impact on an evaluation during a particular service encounter likely relies more on situational cues than social, cultural or historical ones.

At a meso-view of value, however, the evaluation of the service of the train may include information beyond a particular service encounter and to include overall attitudes towards a service provider as well as the socio-technological aspects of value and value co-creation. From this viewpoint, important factors may include the types of technology integrated into the transportation delivery system, such as the core technology that enables a train to function. In addition, supplemental technologies can potentially enhance the experience of multiple travelers, such as wireless Internet and a mobile application that informs passengers of changes in the schedule. The focus of phenomenological value is placed on the necessary components that enable the enhancement of multiple experiences for multiple beneficiaries, including passengers and the organizations providing the transportation services. Service providers should consider the value derived and determined by customers through individual service encounters. This is an important perspective because customers make exchange decisions based on past experience and overarching value propositions. An employee who is tasked with engaging with customers directly will also benefit from understanding the wider socio-technological context contributing to value creation. This market feedback loop can lead to improvement of a current value proposition, or possibly create a new one (Kline 1985).

A macro-view of value requires the consideration of cultural as well as historical contexts as well as considerations of future value creation. From an individual's

perspective, a person's past experiences or experiences in a particular culture shape all evaluations of experience thereafter. For example, if a person who is born in the United States (US) travels to the United Kingdom (UK) she may hesitate when taking public transportation. However, prior experience with public transportation in the US will help this individual with shared norms within the value co-creation process, such as understanding instructions, reading maps and understanding payment options. In this way, prior experience using public transportation, regardless of how unpleasant the original encounter may have been, continues to help co-create value in a separate situational exchange context. In addition, if an individual is focused on creating future value for himself and for society, he might make specific choices, such as taking public transportation instead of driving. He may also interact with particular groups or participate in particular social movements to address related issues, such as global warming.

Value created through present experiences are also relative to past experiences and future expectations. If the UK experience is less pleasant than prior experiences, this will help to change value to perceptions of previous encounters to being more positive, while lessening the perceived value co-created in the new service encounter. Alternatively, if the UK experience is far better than any experience in the US, the individual will reflect on past experiences and view them even more negatively. The present experience is also likely to impact future experiences as he will be more reluctant to use public transportation in the US. In this way, historical views of phenomenological value are shaped not only by past experiences, but by present and future encounters as well. This macro-level view draws attention to past experiences and influences the impact of the present and future service encounters. In other words, whereas a person from the UK might have the exact same exchange encounter as a person from the US, the phenomenological value will differ depending on past experiences and cultural context, and so value is greater than an evaluation of the encounter alone. This is an important consideration for understanding how value is created across cultural and historical contexts.

It is important to note that all of these views could be centered on the same exchange or service encounter (i.e., customer experience journey). Differences in ecosystem perspective, such as individual vs. organization or micro, meso and macro, can alter the phenomenological value derived and determined from a particular service offering. In addition, individual perspectives associated with different historical and cultural contexts can also lead to stark differences in phenomenological value derived and determined in a particular context i.e., value-in-context.

## 20.5 Discussion and Conclusion

The value-in-context concept provides important insights into how context influences individual needs and actions, which influence interactions among multiple actors in systems of service exchange. From this viewpoint, situations, social networks and structures, and cultural meanings all play an important role in the

co-creation of value. Furthermore, the need to understand historical context is central to knowing how evaluations of experience change over time. The value of context is based on its ability to influence the exchange of resources and the subsequent value derived and determined.

Prior research related to S-D logic and value co-creation indicates that value can be conceptualized as the viability of a system (e.g., Vargo et al. 2008). However, the viability of a system may not be the same as phenomenological value—that which is derived and determined through evaluation of an experience in a particular context. That is, perhaps there are different "types" of value that should be considered (e.g., Penaloza and Mish 2011). Views on value do not always align in service systems, a situation that and can lead to conflict. The exchange of resources may or may not lead to a positive evaluation of an experience, and a positive evaluation of an experience may or may not lead to increasing the viability of a system. In this chapter, we have focused on the conceptualization of value-in-context, based on the need to study phenomenological value derived and determined through a specific, but extended context. Although phenomenological value may differ from other "types" of value, this does not mean that these different types of value are not related. This is because phenomenological value contributes to the creation of context by influencing the actions and interactions of multiple actors over time. Misalignment across views on value can be seen as a problem, but it can also be seen as an opportunity for developing novel solutions (i.e., innovation). Understanding the complexity of context and its relationship to value and value creation (Akaka et al. 2013, 2015) can potentially help guide further studies on identifying different types of value within service systems.

By considering how phenomenological value is created across multiple viewpoints organizations can account for the needs of individual customers and individual employees within the context of a service encounter. Drawing on multiple perspectives of phenomenological value, service encounters as well as service systems (e.g., smart cities) can be designed and developed to enhance the experience of both sides of exchange. Although phenomenological value is determined through 'lived experience' and subsequent reflection, the consideration of multiple views on value in designing a particular service encounter (or service system) can help to co-create value for multiple stakeholders. Zooming out and moving between levels of context enables the consideration of multiple views on value, which can potentially contribute to the viability of the overall system. In other words, if value propositions can be designed to balance the exchange value (i.e., sacrifice versus benefits) derived and determined by various individuals, the value created may extend through the wider service system. In the case of urban transportation in smart cities, the phenomenological value for users and service providers at the micro-level will be directly related to the sustainability of the service system as a whole. If no one wants to provide or benefit from micro-level services provided, the long-term viability of the macro-level ecosystem will be questionable, as was seen in the transitions from rowing boats to motor cars as a means of individual transport in London.

When considering value, context is often ignored or excluded by design and by the researcher's measurement instruments. For example, if we are interested in transport we may consider car journeys. Counting cars and noting their direction would give us information of volume and flow and may inform us as to the use of the road and we may identify repeat users from the data. However, we would not know where individuals were going, or crucially why. Standing by a roadside we may also take pictures of cars passing. The images would provide us with details of the vehicles and we can perhaps see the number of occupants. We may get contextual information if we can see weather conditions, but the data it a photograph would also make the cars appear stationary; the instrument removes some of the context—movement. From the data described we could not understand the value proposition of the individual in relation to their journey. To address macro issues of transport need and pollution, we need to begin by understanding the micro situation, 'why do people travel?' Then can then zoom out across different levels of context to gain a deeper understanding of the extended context that frames an exchange or experience (Akaka et al. 2015). Different levels of analysis require different instruments to capture data to address 'why?,' 'who?', 'what?', and 'how?' questions.

Co-creation of value in context is a complicated theoretical proposition that is embedded within SD Logic, distant from practice, and it is difficult to identify how and when it occurs (Kolcaba 2001; Hunt 2002). As depicted in the figures above, value-in-context consists of multiple levels and forms of context, as well as dimensions of value making operationalization and measurement of value-in-context difficult. Thus, in order to gain a comprehensive understanding of value-in-context, multiple methods are required (Parry et al. 2017), that may include, but are not limited to, survey, experiment, case studies, interviews, textual analysis, ethnography, sensor data analysis. There are significant challenges, as measurement methods are based upon differing ontological assumptions, making interpretation difficult and potentially invalidating comparisons between findings.

The broad view of value-in-context proposed in this chapter draws attention to the need for understanding the relationship between different levels of context and varying views on value. A multi-level perspective can help to develop novel and compelling value propositions that can potentially increase value in exchange, use and context. Examining different perspectives can also help researchers to focus on exchange, social and cultural contexts that foster innovative norms and drive the creation of new forms of value and markets. Further developing the conceptualization of value-in-context (Akaka et al. 2013, 2015) helps to fulfill the promise of service science to "provide a foundation for creating lasting improvements to service systems" (Spohrer et al. 2007, p. 76). Future research can empirically investigate specific relationships between nested contexts and the how diverse views on value might be reconciled through the development of new value propositions.

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# Chapter 21
# On the Evolution of Service Ecosystems: A Study of the Emerging API Economy

**Rahul C. Basole**

**Abstract** Service ecosystems can be described as complex, evolving systems of highly interdependent human and non-human stakeholders who co-create value and are shaped by institutions and social norms. The ecosystem lens is increasingly used by scholars and practitioners to describe and understand the complex nature of value creation and emergent industry structures, replacing traditional lenses of value creation. In this chapter we (1) provide a brief, retrospective view of the evolution of service value creation—from the traditional linear value chain perspective to service value networks and ultimately service ecosystems—and (2) describe, through a data-driven analysis and visualization, the emergence of a particular type of service ecosystem, namely the application programming interface (API) economy. The objective of our chapter is multifold. First and foremost is our desire to deepen the appreciation and appropriateness for using an ecosystem lens in the field of service science. Second, we want to underline the importance of digital relationships in service value creation and the particular growth of the API economy. Lastly, we provide a methodological approach for analyzing and visualizing service ecosystems with the hope to provide stimulus for future data-driven studies of service systems.

**Keywords** Service ecosystems · API economy · Network analysis · Visualization

## 21.1 Introduction

To understand a firm's actions, choices, and outcomes, "an ecosystem perspective is neither necessary nor sufficient, but increasingly critical" due to the fundamentally changing nature of economic activities (Adner 2017). Similar to biological systems consisting of a variety of different species with symbiotic relationships, ecosystems

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_21

can also be characterized as a complex set of multilateral ties between a wide range of stakeholders (Iansiti and Levien 2004). These stakeholders can include firms, customers, non-profit organizations, and government agencies (Basole and Rouse 2008).

The ecosystem metaphor for describing economic activities and strategies is not new (see Moore 1996), but has only recently been formalized in the service science domain (Vargo and Akaka 2012). While service systems are a configuration of people, technologies, and other resources that interact with other service systems to create mutual value (Maglio and Spohrer 2008; Maglio et al. 2009; Spohrer and Maglio 2010), service ecosystems are not just networked actors and actions, but also dynamic, evolving systems that are shaped by institutions and social norms (Williamson 2000). According to the service-dominant logic view, and in line with other system thinking approaches, change is thus inherent to the definition of service ecosystems (Lusch and Vargo 2006; Vargo and Lusch 2006, 2016; Akaka et al. 2013; Lusch and Nambisan 2015).

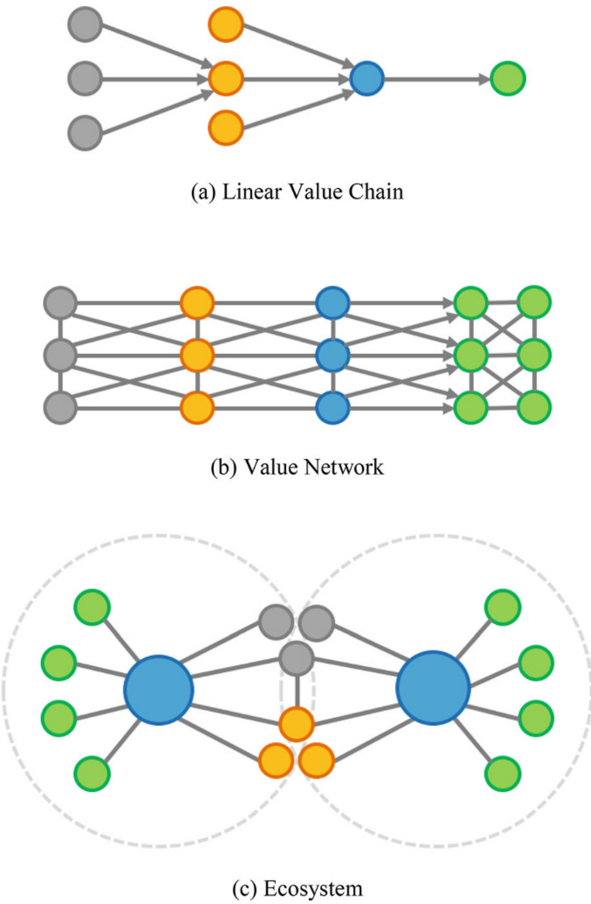
Using this definition, many systems can thus be viewed as service ecosystems including companies, supply chains, and markets, among many others. Given the applicability and increasing importance of ecosystems in describing economic activities, it is thus not surprising to see a significant growth in studies using an ecosystemic lens across a variety of management disciplines including service science. Moreover, the rapid evolution of digital technologies is transforming economic activities at an unprecedented speed, scale, and scope. Indeed, traditional interfirm relationships are increasingly complemented and replaced by digital relationships between companies. This is particularly visible in the emerging application programming interface (API) economy, in which firms are offering access and the ability to recombine their digital services and products for novel value creation.

The overarching aim of this chapter is to (1) provide a brief, retrospective view of the evolution of service value creation—from the traditional linear value chain perspective to service value networks and ultimately service ecosystems—and (2) describe, through a data-driven analysis and visualization, the emergence of a particular service ecosystem, namely the API economy. In doing so, we hope to contribute to our understanding of service science in multiple ways. First, we will deepen the appreciation and appropriateness for using an ecosystem lens in service science. Second, we will underline the importance of digital relationships in service value creation and the particular growth of the API economy. Lastly, we will provide a methodological approach for analyzing and visualizing service ecosystems with the hope to provide stimulus for future data-driven studies of service systems.

## 21.2 From Chains to Networks to Ecosystems

The traditional view of understanding and analyzing industries has largely been shaped by the concept of a value chain, which assumes a linear value flow and where resources flow through “chained” dyadic relationships from raw material providers and manufacturers to suppliers and customers (see Fig. 21.1a) (Porter 1980). This view has long been proven appropriate for understanding economic activities within

Fig. 21.1 Conceptual representation of the evolution of value creation configurations




traditional industries, in particular manufacturing. Within this economic view, the product was the primary focus and there was clear demarcation between producers and consumers. This perspective framed our ideas of value and value creation for many years.

Critics, however, found that the linear view of economic activities did not adequately describe and capture the multidirectional nature and complexities of the potential myriad of relationships between different stakeholders. There was a growing recognition that the network, rather than the individual firm, was becoming the focal point of economic and business activities (Buhman et al. 2005; Dyer 2000). Driven by increasing competition on a global scale, market pressure to innovate, and continuously changing customer demands and expectations, product and service creation and delivery transformed from a linear value chain flow into a complex web, or value network, of large-scale interfirm activities (see Fig. 21.1b) (Basole and Rouse 2008).

In these networks, value is provided by a myriad of multidirectional relationships across and between stakeholders. As a result, products and services are designed,

created, delivered, and provided to customers by enterprises comprising a complex web of processes, exchanges, and relationships (Chesbrough and Spohrer 2006; Vargo and Lusch 2004). The value network assumes firms to be part of a larger complex networked system of enterprises that together create (i.e., co-create) value (Spohrer et al. 2007; Basole and Rouse 2008; Dyer 2000). The value network approach thus views the activities of a firm in a holistic, rather than a fragmented manner. Consequently, the network perspective shifts the focus of a resource-based view of the firm to a perspective in which examination of resource dependency, transaction costs, and actor-network relationships is critical (Spohrer and Maglio 2008; Basole et al. 2011).

More recently, there has been growing recognition that industries exhibit complex, emerging, dynamic characteristics typically found and exhibited by natural systems. Strategy scholars found the use of using an ecosystemic lens to be particularly useful in describing economic activities, stakeholder roles and relationships, and their emergent dynamics (Iansiti and Levien 2004, Adner 2017). In his seminal work, James Moore (Moore 1996) described (business) ecosystems as:

> "An economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organism also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the direction set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles." (Moore 1996: p. 26)

Following this definition, an important tenet of ecosystemic thinking is that an ecosystem is composed of multiple firms that symbiotically create value. Each firm has their own ecosystem strategy corresponding to their structure, position, and risk profile (Adner 2017). These ideas follow the Iansiti and Levien (2004) definition of ecosystem role archetypes that firms assume. Firms can be keystones, niche players, dominators, or hub landlords. The evolution of these value configurations and roles mirror the idea of market evolution. In an ecosystem-centric world, core firms assume a platform position, connecting two-sides of a market (see Fig. 21.1c) (Dhanaraj & Parkhe 2006; Parker et al. 2016).

Figure 21.1a–c provide a conceptual representation of the evolution of these industry structures. Value is generated at each interconnection between the stakeholders and is ultimately captured by the consumer (Basole and Rouse 2008; Rouse and Basole 2010). In the ecosystem configuration, platform companies (depicted in blue) are critical in connecting different stakeholders (such as suppliers and partners (depicted in orange and gray) and consumers (depicted in green) in the ecosystem.

Conceptually, our lenses of studying economic activities have evolved over time from dyads to chained activities of multiple actors to networks and webs of interactions. In part our lenses have evolved and adapted to the realities of economic activities from simple relationships to increasingly complex configurations of firms. This evolution has largely been driven by different forces, including economies of scale, vertical/horizontal differentiation, specialization, and globalization.

The prevailing thread throughout this evolution has been the rapid prominence of information and communication technologies (Westerman et al. 2014; Akaka and Vargo 2014; Rogers 2016). While humans and social entities are centric to service systems, we are increasingly observing that entire economic activities are replaced by human to machine (H2M) and machine to machine interactions (M2M) (Weill and Woerner 2015). Consider how consumers interact with the customer service function of firms. Customers dial a customer service number and are frequently initially greeted not by a human but rather by an automated message system that routes the call using complex decision rules. Indeed, many human-centric services are augmented by computerized systems and chatbots. Some economic activities in fact are now entirely delegated to machine to machine transactions, such as financial trading services.

This new sphere in the service ecosystem ecology is amplified by the growth of digital connectors and control points that allow various parts of the infrastructure to be interconnected and made smarter to respond, act, learn from the action (Pagani 2013). These digital control points, sometimes also referred to as boundary resources, have been critical to the growth of the digital economy (Ghazawneh and Henfridsson 2013). In fact, it has been argued that traditional interfirm service relationships will be increasingly replaced and augmented by these digital boundary resources (Iyer and Subramaniam 2015).

## 21.3 Case Study: The Evolution of the API Ecosystem

One digital service ecosystem that is gaining substantive importance is the application programming interface (API) ecosystem. APIs can be described as "bits of code" that act as digital control points which set the terms with which digital data and services can be efficiently shared or called over the Internet (Tilson et al. 2010). The API economy has grown exponentially over the past decade, with most leading firms offering some APIs for their services and products. According to recent reports, there are more than 18,000 publicly available APIs across a wide range of market segments (ProgrammableWeb 2017). APIs are not really a new concept. Interconnecting digital resources using "interfaces" has been a feature of computing infrastructure for many years. However, with the rise of mobile computing devices, significantly lower cost of data storage, and the explosive economic value of making digital data available to the public, the growth rate of these digital control points has been staggering. Today's leading firms all offer APIs and handle an enormous number of calls daily. Recent reports, for instance, have shown that companies like Google, Amazon, Facebook, and Netflix easily handle over a billion API calls every day.[1] It is not surprising that firms are racing to create and join this form of digital service ecosystem. Prior work has examined the overall structure of the API

[1] https://www.forbes.com/sites/ciocentral/2012/08/29/welcome-to-the-api-economy.

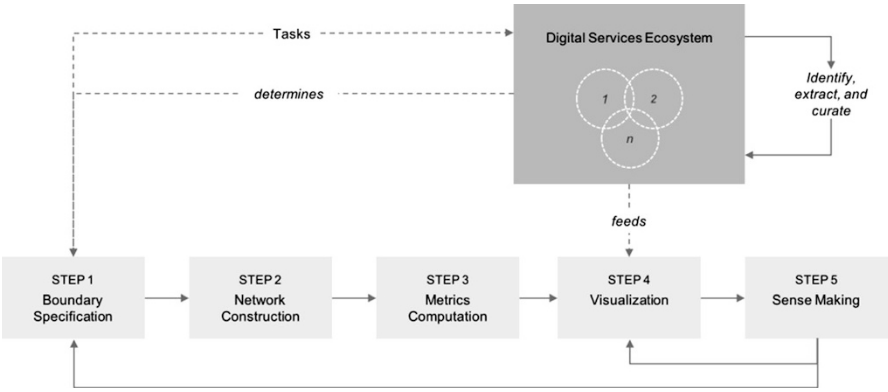



**Fig. 21.2** Multi-stage ecosystem analysis and visualization methodology (adapted from Basole et al. 2015a, b)

ecosystem (Evans and Basole 2016), sectoral differences in the use of APIs (Basole et al. 2018), and the geographic distribution of API offerings (Huhtamäki et al. 2017). In this data-driven case study, we build on this prior work to illustrate how the API ecosystem has evolved over time, thereby offering an important evolutionary lens on this type of digital service ecosystem.

## *21.3.1 Methodology*

Following Basole et al. (2015a, b), we propose a five-step process for understanding the evolving structure of the API ecosystem. The effectiveness of this method has been demonstrated in several service domains, including the mobile ecosystem (Basole and Karla 2012), innovation ecosystems (Russell et al. 2015), and the emerging FinTech ecosystem (Basole and Patel 2017). Specifically, our approach includes the following steps: (1) ecosystem boundary specification, (2) network construction, (3) metrics computation, (4) visualizing, and (5) sensemaking. Figure 21.2 provides a conceptual overview of the overall approach. In doing so, our approach builds on the well-established information visualization reference model (Card et al. 1999) which advocates for a balance between data management, visual mappings, computer graphics, and interaction.

### 21.3.1.1 Step 1: Boundary Specification

An important first step in service ecosystem analysis is the specification of boundaries. The challenge in defining boundaries is that service ecosystems are evolving systems, with stakeholders (firms, customers, suppliers, machines, etc.) continuously entering and leaving. Rather than taking a firm-level centric approach, an alternate view is to select relevant market segments that make up the service ecosystem.

However, even when using segments we face a similar inclusion challenge as segments are often related to each other. Ultimately, the choice of what to include is driven by the nature and intent of the problem, the questions being asked, and the costs involved (Basole et al. 2015a, b).

In our study context, boundary specification involves determining the primitives of the API ecosystem architecture (Ahuja et al. 2012), including nodes, node types, relationship types, and specification of the desired analysis timeframe. We used a top-down approach, first identifying all APIs and then filtering down to those most commonly found. In doing so, we eliminated APIs that were not widely used and/or relatively novel.

One of the most widely used datasets for the study of APIs is ProgrammableWeb (PW), a socially curated directory of publicly-available APIs and Mashups. Several prior studies have used PW (e.g. Evans and Basole 2016; Huhtamäki et al. 2017). ProgrammableWeb contains a range of API descriptors, including a description, category tags (e.g., Mapping, Social, etc.), API endpoint URL, types of protocols an API uses (RESTful, etc.), security, some measures of popularity and social share, and a list of Mashups that use it. As of March 15, 2017, there were 17,132 APIs listed. It needs to be acknowledged that using publicly-available APIs only is a limitation. Many firms offer private APIs that are only shared with their direct customers and suppliers. To the best of our knowledge, however, there is no single data source that comprehensively captures all publicly- and privately-available APIs. We thus only focused on publicly available ones. Since our focus was on the most commonly used APIs, which have been used in mashups, our sample reduced significantly.

#### 21.3.1.2 Step 2: Network Construction

We constructed the API ecosystem network consisting of APIs using a weighted adjacency matrix approach, with cell entries marked as the total number of mashups formed between a pair of APIs and 0 otherwise. In doing so, we explicitly accounted for the differing degree of funding flow that may exist between firms. Moreover, as mashups are inherently non-directional, our ecosystem network resulted in an undirected unipartite graph. Given our interest in the structural evolution, we used the release date of an API to create annual temporal snapshots of the API ecosystem from 2005–2016.

#### 21.3.1.3 Step 3: Metrics Computation

The advantage of conceptualizing API ecosystems as networks is the availability of a wide range of established metrics. There are many social network as well as information and graph theoretic metrics that have proven to be useful for understanding the structure and dynamics of a business ecosystem, in general, and API ecosystems in particular. The selection of metrics is generally driven by the insight

objectives and decision processes. Broadly speaking, metrics fall into two levels of analysis: the node level and the network level (Zaheer et al., 2010). Node metrics provide insight at the individual entity level, while network metrics describe the entire ecosystem. Based on prior related work (Iyer et al. 2006; Rosenkopf and Padula 2008; Basole et al. 2015a, b; Basole and Karla 2012), we compute several metrics at the network level using NetworkX, a Python-based library for graph computations.[2]

One of the most commonly used graph-based ecosystem metrics is node centrality (Wasserman and Faust 1994). Centrality refers to the relative importance or prominence of a firm in the ecosystem, where firms with higher levels of centrality are found to have more power and control over peripheral firms. There are many variants of centrality, such as those based on direct ties (degree), shortest path (closeness), geodesic distance (betweenness), or recursive importance (eigenvector). Each captures a different aspect of firm power and influence in an ecosystem. In our study, we use degree, weighted degree and betweenness centrality to understand the importance of APIs in the API ecosystem. Another node-level measure of frequent interest is the clustering coefficient, defined as the proportion of a firm's direct links that are also directly linked to each other. In the context of ecosystems, firms with dense clustering have been shown to experience greater collaboration, resource pooling, and problem solving due to increased trust among partners (Schilling and Phelps 2007).

At the network level, density refers to the proportion of ties in the network over the maximum possible number of ties. The more dense the ecosystem, the more interconnected it is. Another common measure in understanding the structure of ecosystems is the average path length. Average path length measures how far (i.e. "steps") any two APIs are in an ecosystem. The shorter the path length, the more accessible and interconnected an ecosystem is. Modular communities are defined as groups of densely interconnected nodes that are only sparsely connected with the rest of the network (Blondel et al. 2008). Small-world networks have characteristics of high clustering and small average distance between nodes.

#### 21.3.1.4 Step 4: Visualization

Visualizations are a fundamental component of human learning and understanding and a key step in transforming data to knowledge (Card et al. 1999). They can be used to explore, interpret and communicate data and aid decision makers with overcoming cognitive limitations. By mapping data to visual encodings, visualizations of ecosystems make the "what, why, how, and who" explicit. Prior work has provided important novel and complementary insights into the structure, dynamics, and strategy of business ecosystems (Basole 2009. 2014; Basole et al. 2013; Iyer and Basole 2016).

[2] https://networkx.github.io/.

There are many different visual representations available, ranging from simple to complex. A comprehensive review is beyond the scope of this paper, but interested readers are referred to Card et al. (1999) and Heer et al. (2010) for excellent overviews. Given that the structural aspect is of particular interest in this study, we leverage network visualization techniques to depict the interconnections between APIs in an ecosystem. Network visualizations require the development of appropriate types of representations, placement of graph elements on the screen, and efficient mapping of visual attributes for improved readability.

There are many examples of network visualizations including biological and ecological networks, social networks, the Internet and citation networks (Newman 2003). Visualizations of industry networks are also emerging and are used as complementary analyses to traditional statistical summaries (e.g. Rosenkopf and Schilling 2007). It has also been shown that graph visualizations are particularly valuable for understanding and analysing business issues, including competitive intelligence, strategy, scenario planning and problem-solving (Basole et al. 2013).

Ecosystem visualization, however, is challenging and resource-intensive. As discussed above, complete or even comprehensive ecosystem data is generally not available. At the same time, even if the data is collected and appropriately curated, the amount of information can often be overwhelming to the analyst if not presented appropriately (Tufte and Graves-Morris 1983). Effective visualizations must therefore ensure a careful balance between detail, abstraction, accuracy, efficiency, and aesthetics (Card et al. 1999).

We use Gephi 0.9,[3] an open-source software for visualizing and analysing large network graphs, to create graphical representations of the structure of the API ecosystem (Bastian et al. 2009). Specifically, we use OpenORD, a force-directed network layout (Martin et al. 2011). A force-based layout is based on the idea that network entities are shaped by mechanical laws, assigning repulsive forces between nodes and attraction forces between endpoints of edges. The use of a force-based layout is particularly appealing when the motivating issue is to identify central or prominent nodes, peripheral actors, or clusters in an ecosystem. The OpenORD layout uses five stages that leverage different physical "laws": liquid, expansion, cooldown, crunch, and simmer. We use an initial parameter configuration of these stages to emphasize core, periphery, and clusters (Liquid: 25%, Expansion: 25%, Cooldown: 25%, Crunch: 10%, Simmer: 15%). Moreover, to ensure readability and aesthetics, we followed several visual design principles, including no node overlap and edge crossing minimization. In all our network visualization, node size is proportional to the firm's importance as measured by degree centrality. To gain insight into the distribution of API categories in the API ecosystem, we color encode nodes with the corresponding primary category (see Appendix A for color encoding details). We use a NoOverlap algorithm to space out nodes and address potential visual occlusion issues.

[3]http://www.gephi.org.

#### 21.3.1.5 Step 5: Sensemaking

The ultimate purpose of visualizations is not to create pretty pictures (although aesthetics matter), but rather human insight and foresight (Card et al. 1999). While visualization is primarily about data transformation, representation, and interaction, it is also about harnessing human visual perception capabilities to help identify trends, patterns, and outliers with computational capabilities (Card et al. 1999). It involves the formation of abstract visual metaphors in combination with a human information discourse (interaction) that enables detection of the expected and discovery of the unexpected within massive, dynamically changing information spaces (Thomas and Cook 2006).

Sense-making has its roots in cognitive psychology and many different models have been developed. The consensus across these models is that the sense-making process is cyclic and interactive, involving both discovery and creation (Basole et al. 2016). During the generation loop an individual searches for representations. In the data coverage loop, we instantiate these representations. Based on these insights, we shift our representation and begin again. Together this forms a complete sense-making loop. Visualization of digital service ecosystems can therefore be seen to support the electronic market sense-making process. Through visualizations we look for confirmation, inconsistencies, and possible "aha" moments. If confirmation is not achieved, we return to develop alternative visualizations or specify new boundaries.

### *21.3.2 Results and Analysis*

Prior to our visualizations, we provide a summary of the evolution of structural characteristics of the API ecosystem (see Table 21.1). Specifically, we present our results across three main periods (2005–2008, 2009–2012, and 2013–2016),

**Table 21.1** Evolution of API ecosystem metrics

| | 2005–2008 | 2009–2012 | 2013–2016 |
|---|---|---|---|
| Nodes (API) | 192<br>(MC[a]: 132, 68.75%) | 412<br>(MC: 314, 76.21%) | 488<br>(MC: 449, 92.01%) |
| Edges (Mashups) | 293<br>(MC: 289, 98.63%) | 868<br>(MC: 860: 99.08%) | 1230<br>(MC: 1198, 97.4%) |
| Average degree | 3.052 | 4.214 | 5.041 |
| Avg. weighted degree | 8.491 | 11.092 | 12.681 |
| Network diameter | 6.000 | 7.000 | 9.000 |
| Density | 0.016 | 0.010 | 0.010 |
| Modularity | 0.240 | 0.285 | 0.300 |
| Avg. clustering coefficient | 0.706 | 0.658 | 0.653 |
| Avg. path length | 2.645 | 2.810 | 3.008 |

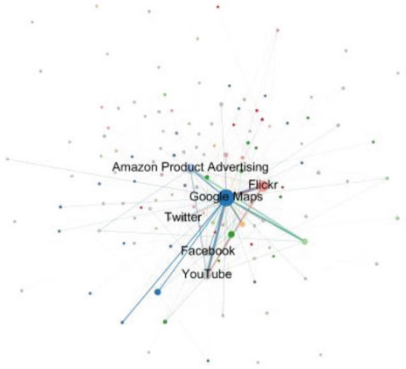
[a]The main component (MC) of a network refers to the largest connected subgraph. It is also often referred to as the giant component

denoting different epochs of the API ecosystem. First, and not surprisingly, we observe that there has been a rapid growth in APIs over the past decade. APIs represent service value providers and enablers. Interestingly, the number of mashups, or service value recombinations, have grown significantly more, suggesting that much of the core digital service functionalities is already present and that service value innovation is occurring more frequently through recombinations. While the overall density in the API ecosystem has decreased (highlighting the asymmetric growth between APIs versus novel mashups), the average number of recombinations per API has increased (as evidenced by the average degree). Interestingly, the average clustering coefficient, which is a measure of how interconnected APIs are for a given focal API, has slightly decreased, suggesting that focal APIs play a more important role in the API ecosystem. Lastly, while the overall API ecosystem is growing in size (number of APIs), both the network diameter and the average path length have modest increases, suggesting that the overall interconnectedness and reach are growing potentially due to some possible niche value creation.

While summary statistics provide a quick overview of the overall nature of the API ecosystem, visualizations are more suitable for understanding the underlying structure, including prominent APIs, clusters, and outliers. Figure 21.3a–c presents three visualizations, each representing one of the time periods. Based on our aforementioned ecosystem analysis and visualization approach, nodes represent APIs and edges are mashups. Nodes are proportionally sized by the degree of the API and color-encoded by their primary category.

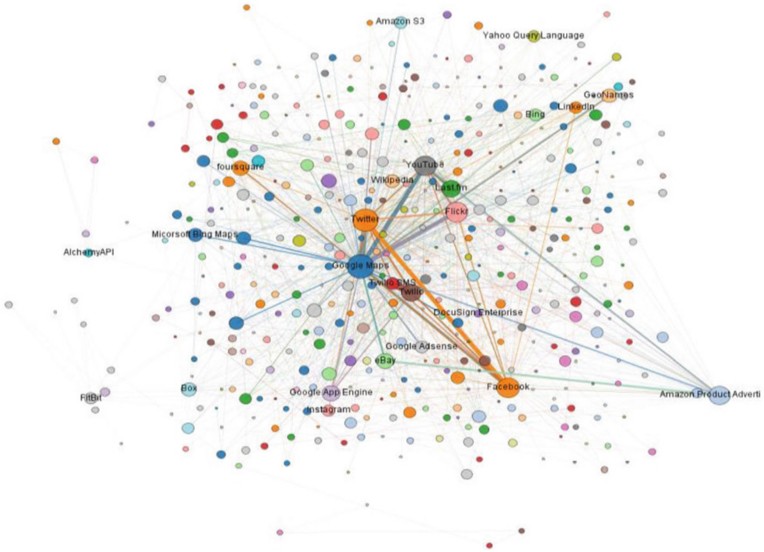
The visualizations quickly confirm the findings from our statistical analysis that the overall size of the API ecosystem has grown significantly over the past decade. Moreover, we can see that several of the early APIs in the ecosystem are core actors throughout all periods. These include Google Maps, Facebook, Twitter, Amazon Product Advertising, eBay, and YouTube. The visualizations, however, also reveal that Google Maps plays a particularly central role in the API ecosystem. Indeed, mapping (dark blue), e-Commerce (light blue), and social (orange) APIs are the most relevant APIs today. We also note that analytic, finance/payment, and health/wellness related APIs are relatively recent offerings, suggesting temporal differences in value creation in the API ecosystem.

The temporal structural analysis and visualizations of the API ecosystem confirm that significant sectoral differences exist, suggesting potentially diverging value creation paths (Basole 2016). The visualizations also reveal that while there was initially one core cluster, the API ecosystem is emerging to have a core cluster with several peripheral clusters focused on specific areas of service value creation. At the same time, we note that core APIs remain highly influential over time, suggesting that there are economies of scale that can be gained by providing relevant digital service offerings. Of course, some differences appear and further analysis is needed.




(b) through 2008


(b) through 2011




(c) through 2016

**Fig. 21.3** Snapshots visualizing the evolution of the core component of the API ecosystem (2005–2016). Nodes represent APIs, edge are mashups. Nodes are sized by degree and color encoded by their primary category

## 21.4 Concluding Remarks

In this chapter we provided a brief view of the evolution of service value creation, proposed a methodology that can be applied to analyze and visualize any service ecosystem, and illustrated our approach through a data-driven analysis and visualization of one rapidly emerging type of service ecosystem, namely the API ecosystem.

Historically, technologies have always disrupted and transformed (service) ecosystems. The evolution, however, appears to have accelerated in this new age of APIs. The importance of APIs is particularly amplified with the emergence of the idea of the "everything-as-a-service" (XaaS) paradigm, which envisions business capabilities, products, and processes not as discreet vertical offerings operating individually in silos but, rather, as a collection of horizontal services that can be accessed and leveraged across organizational boundaries.

The implications of digitally-connected products and services are wide ranging. With everything connected, service ecologies are naturally bound to grow in scope and scale. APIs will enable firms to pursue rapid experimentation and innovation in addition to value provision. New value propositions will emerge through novel API recombinations. Many contemporary enterprise systems are already designed with an API-centric model. However, companies are increasingly layering APIs on top of their legacy systems to modernize their core infrastructure making it possible to reuse, share, and monetize core assets and data in the XaaS world. It is critical to note that simply deploying APIs is not sufficient to succeed in today's digital services economy. Firms must also carefully craft an appropriate API management strategy that considers the plethora of issues involved in designing, exposing, contracting, servicing, metering, and billing based on API usage.

While there are many positive effects of this new service ecosystem reality, there will also be massive service ecosystem challenges. Technological challenges, for instance, will include an ability to manage and integrate a diversity of "actors", provide sufficient control and security mechanisms, and create architectures that continuously scale and adapt to changes. Economically, these new service ecosystems will demand new ways of conducting business, requiring different types of business models that facilitate a diversity of expectation and transactions, perhaps more loosely connected than ever before. From a policy perspective, these new service ecosystems have massive implications for governance, taxation, and geographic boundaries. For instance, data in these service ecosystems may be geographically distributed, and if so, what data residency requirements will apply? How will privacy and security be ensured? And how will policies be enforced? Each of these challenges provide fertile ground for fundamental service science research.

Ultimately, the reality in these emerging service ecosystems is that no firm is and will be an island by itself. It interacts through complex, evolving relationships - whether material or digital - with a myriad of different stakeholders. It can be reasonably argued that for firms to succeed over time they need to adopt service ecosystem strategies, structures, and positions that can adapt to changing

institutional and environmental conditions. In an increasingly digital world this means adopting flexible digital infrastructures with open control points (i.e. APIs) that allow dynamic value configuration and (re)combination.

## Appendix

For consistency and ease-of-interpretation, we used a consistent color encoding scheme of the APIs in the ecosystem visualizations. We leveraged the Tableau 20 palette to encode 20 API categories (including Others). The color legend is shown in Fig. A1.


**Fig. A1** Color legend for visualizations

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# Chapter 22
# Institutionalization Process of Service Innovation: Overcoming Competing Institutional Logics in Service Ecosystems

**Elina Jaakkola, Leena Aarikka-Stenroos, and Paavo Ritala**

**Abstract** Service science is concerned with the question of how systems can co-create value in an optimal way. In essence, innovations aim at enabling better value co-creation; but at the same time, cause disruption and tensions in the service ecosystem by challenging prevailing practices. This chapter examines the development and diffusion of a broad scale heath care service innovation—the Electronic Prescription system (eRX)—as a process of institutionalization within a service ecosystem. This case represents an innovation process that attempts to solve a major societal challenge, rationalization of medication and reduction of medication errors and abuse. This change requires commitment and adaptation by diverse actors in multiple service systems affected by the eRX, but is nearly disabled by these actors' competing and even conflicting institutional logics. We examine how diverse stakeholders slowly move towards a convergent institutional logic as the innovation is gradually institutionalized in the broader service ecosystem, and discuss the major challenges along this process. This chapter highlights the dilemma of change in service ecosystems and highlights the role of institutions therein.

**Keywords** Service innovation · Service systems · Service ecosystems · Institutionalization · Institutional change · eHealth

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_22

## 22.1 Introduction

Service science is concerned with the question of how systems can co-create value in an optimal way (Maglio and Spohrer 2008). In essence, innovations aim at enabling better value co-creation; but also cause disruption in the service ecosystem. In order to create value, the innovation has to resonate with the needs, practices, values, and institutional structures of the market and all of society, so that actors are able to make use of the new resource or in their value processes (Edvardsson and Tronvoll 2013). At the same time, however, an innovation typically causes change and disruption in the prevailing system, and new practices and structures may be needed before the value can be realized (Koskela-Huotari et al. 2016). For example, many innovations in the health care industry aim at reducing health care costs, but the prevailing institutions such as administrative, technical, or legislative infrastructure and systems do not support or adapt for the necessary change, or even protect the health care regime against radical innovations (Wallin and Fuglsang 2017). Reflecting such notions, Vargo et al. (2015) argue that *institutionalization*, i.e. the maintenance, disruption, and change of institutions, is a central process of innovation. Understanding how such process of institutionalization occurs, and what kind of obstacles it involves is therefore pivotal for advancing value co-creation through innovation in service ecosystems.

This chapter examines the development and diffusion of a broad scale heath care service innovation—the Electronic Prescription (eRX)—as a process of institutionalization within a health care service ecosystem. This case represents an innovation process that attempts to solve a major societal challenge, rationalization of medication and reduction of medication errors and abuse. This change requires commitment and adaptation by a diverse set of actors ranging from public organizations to business actors and citizens that are affected by the eRX, but is nearly disabled by these actors' competing or even conflicting *institutional logics*—the "deep-structural rules that coordinate and guide actor's perceptions and actions" (Geels 2012, p. 3). Existing research has shown that change taking place in markets often involves competing institutional logics and a battle for legitimacy and power (see e.g. Fuenfschilling and Truffer 2014). The institutionalization of a radical innovation therefore implies changes in the institutional logics within the service ecosystem as it involves the reshaping of institutions to better suit the new practices required by the innovation (cf. Geels and Schot 2007; Edvardsson et al. 2014). In this chapter, we highlight the challenges posed by competing institutional logics, and examine how the eRX service ecosystem slowly moves towards convergent institutional logics, i.e. similar or complementary interests and goals (Öberg and Shih 2014), as the innovation is gradually institutionalized.

Previous innovation research has highlighted that *divergent* logics between actors can be a source of innovation, as diverse actors can complement each other, but convergent logics among innovating actors is also needed to support the successful development and commercialization of innovation (Öberg and Shih 2014; Aarikka-Stenroos et al. 2017). However, despite highlighting the relevance of the

stakeholders and diverse ecosystem actors surrounding the innovation, this research has predominantly focused on the technical development of the innovation (e.g., Rohrbeck et al. 2009), typically by actors involved in formal partnerships (e.g. Eisingerich et al. 2009). Less research has been conducted to address the whole process throughout which novel service processes evolve and become regimes in the interplay of versatile actors, i.e. how service innovation is institutionalized in the service ecosystem. This aspect is relevant especially in the case of radical innovations as "radically new technologies have a hard time to break through, because regulations, infrastructure, user practices, and maintenance networks are aligned to the existing technology" (Geels 2002, p. 1258).

This chapter contributes by highlighting the development and diffusion of major innovation as a process of institutionalization, analyzing in particular how competing institutional logics create tensions and barriers along this process in service ecosystems. As institutional logics shape individual and organizational actions (Thornton and Ocasio 2008), it is fruitful to examine how diverse actors with differing institutional logics achieve directions for joint actions, and the key obstacles therein. Development of convergent institutional logics has been identified a critical step for innovation to diffuse to markets, and gain legitimacy across relevant stakeholders (Wallin and Fuglsang 2017). This understanding is pivotal for gaining a broader view of service innovation that is interdisciplinary in nature, involving changes in technological, business, and human practices (Spohrer and Maglio 2008).

This chapter proceeds as follows. The next sections provide the conceptual basis of this study, discussing innovation as a process of institutionalization affected by institutional logics of the ecosystem actors. Next, we introduce the empirical case study of the development and diffusion process of the Electronic Prescription system in Finland. Subsequent sections analyze the empirical case as a process of institutionalization of innovation, and outline how competing institutional logics held by ecosystem actors challenge this process. Finally, we discuss the theoretical and practical implications of our research.

## 22.2 Service Ecosystem Actors and Institutionalization of Innovation

We start by discussing service ecosystems that serve as the context for innovating and comprise diverse actors who affect, and are affected by the institutionalization of innovations. Drawing from Service-Dominant (S-D) Logic, service ecosystems are defined as *relatively self-contained, self-adjusting systems of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange* (Vargo and Lusch 2015). Value creation in service ecosystems is therefore affected by resources and contributions of a vast range of actors, such as customers and their social networks, businesses such as manufacturers and retailers, as well as actors that control or allocate public resources (Akaka

et al. 2013). Health care service ecosystems comprise very divergent actors, including patients and their families and friends, healthcare professionals, hospitals, health support agencies, professional associations, health insurers, healthcare authorities, government agencies, and regulatory bodies (Frow et al. 2016; Litovuo et al. 2017; Verleye et al. 2017), as well as the technologies that the ecosystem applies (e.g., Capunzo et al. 2013).

Innovation can be understood as a process of exchanging and combining resources in new ways between actors in the service ecosystem (Perks et al. 2012). Innovation therefore induces chances in the practices of value co-creation among ecosystem actors (Vargo et al. 2015), and at the same time, necessitates that ecosystem actors are willing and able to engage in new practices (Edvardsson and Tronvoll 2013). As institutions, i.e. rules, norms, values and beliefs, and institutional arrangements, i.e. sets of interrelated institutions, provide the overall structure for how resources are integrated, innovation implies institutional change (Koskela-Huotari et al. 2016). The process of *institutionalization*, referring to the maintenance, disruption and change of institutions (Lawrence and Suddaby 2006), is therefore central for innovation (Vargo et al. 2015). One actor alone is a not able to maneuver such structures, but a dynamic and iterative process involving multiple stakeholders in the ecosystem that each have varying views on value is needed to maintain or change practices, and thereby ultimately institutionalize innovation (Vargo et al. 2015).

Resonating such notions, innovation research has emphasized that various actors and stakeholders such as distributors, consultants, suppliers, research institutes and universities, government agencies, and associations can impact the success of innovation by advancing or hindering development and commercialization (Aarikka-Stenroos et al. 2014; Rusanen et al. 2014) and therefore influence its institutionalization in the market/society (Geels 2002). For example, intermediaries are crucial in the case of consumer products because they make the product available to users (Woodside and Biemans 2005). Public organizations and educational institutions may support the diffusion by articulating positive visions of the use of the innovation in society (Troshani and Doolin 2007); and public and political authorities shape priorities of innovative actions (Geels 2002). Furthermore, expert opinion leaders, lead users, and user groups impact the formation or change of opinion, provide publicity, give advice and function as lead-teachers, demonstrate the new product, and explain its unique benefits over what is currently available and thus accelerate or block the adoption of the product (Woodside and Biemans 2005; Harrison and Waluszewski 2008; Aarikka-Stenroos et al. 2014).

The ecosystem actors' contributions to the innovation can be divided into three groups (Aarikka-Stenroos et al. 2014): at strategic level actors create markets for innovations, as regulators, investors, public organizations, and media as well as related firms together shape markets by breeding ecosystems; at more practical level users, media, and divergent organizations and communities build awareness and educate other actors and markets on the employment and benefits of the innovation; and finally all adopters and users facilitate and accelerate further adoption in markets by impacting attitudes and choices, and by creating the influence of critical mass.

## 22.3 Institutional Logics and Innovation

To understand institutionalization and institutional logics, we need to outline what we mean by institutions. The most typically adopted categorization follows three institutional pillars as defined by Scott (1995): (1) regulative institutions manifested by the existence of rules, laws, sanctions that constrain and regularize behavior; (2) normative institutions defining what is appropriate, i.e. what are the goals as well as the appropriate means of achieving them; and (3) cultural/cognitive institutions referring to culturally supported practices taken for granted. Together, institutions set the "rules for the game" in a given industry and affect resource integration by individual actors. Institutional settings (e.g. norms, rules, standards) of service systems affect individual actors' intensions, motivations and behaviors, but also the actions taken by actors influence existing institutions (Edvardsson et al. 2014). A broad range of actors engage in modifications and accommodations of institutional arrangements while acting and interacting to create value for themselves and for others, and at the same time their actions are enabled and constrained by institutional arrangements that are at least partially shared by the actors within a service ecosystem (Wieland et al. 2016).

Institutional logics, then, consist a particular system of socially constructed interpretations of how actors can operate under perceived institutional contexts. Institutional logics can be described as "deep-structural rules that coordinate and guide actor's perceptions and actions" (Geels 2012, p. 3) or "the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" (Thornton and Ocasio 1999, p. 804).

As discussed earlier, innovations are never only about technology, as their diffusion is a socially and institutionally embedded process. For instance, Geels (2002, p. 1257), notes that technological transitions "do not only involve changes in technology, but also changes in user practices, regulation, industrial networks, infrastructure, and symbolic meaning or culture". For radical innovations this often means that the institutional framework is poorly structured, including lack of coherent and shared economic and market structures, cognitive structures, user preferences and regulations (Geels and Schot 2007, p. 403). Furthermore, new technologies might be misaligned with the existing institutions, leading to the lack of legitimacy among focal institutional dimensions (Markard et al. 2016).

Therefore, the stronger the institutional structure around the innovation, the better the chances of its adoption—and vice versa. In this regard, it has been suggested that 'levels of structuration' of institutions can be viewed as the degree of institutionalization (Fuenfschilling and Truffer 2014). Furthermore, as the level of institutionalization grow, so does the commonly shared institutional logics (Thornton et al. 2012). In service ecosystems one of the core issues that enable their coordination is the shared institutional logics among the relevant ecosystem actors, including individuals, organizations, as well as policy-makers (see e.g. Vargo et al. 2015). This accentuates the need for creating convergent logics among actors affected by the innovation.

## 22.4 Competing Institutional Logics as Barriers to Institutionalization

In this paper we focus particularly on barriers for diffusion and adoption and the consequent institutionalization of innovation. Even though interest on innovation barriers has been growing, the barrier approach remains a much smaller and less-organized research stream than the driver approach (Mohnen and Rosa 2002). Innovation barriers are issues that either prevent or hamper innovative activities: they can be “total barriers” that prevent innovative activities in firms or they can be understood as obstacles that can be overcome with effort (e.g., D’Este et al. 2012; Sandberg and Aarikka-Stenroos 2014). Barriers are largely relative and context dependent; what constitutes a barrier and the extent to which it hampers innovative activities depends on the firm and its characteristics (Sandberg and Aarikka-Stenroos 2014). Barriers can occur on systemic levels such as in the case of large technical systems that tend to be strongly path-dependent; in such situations there is a need to overcome prevailing standards and to compete against the established product and technologies (Markard and Truffer 2006). Some barriers are positioned in structures and concern routines, changing status-quo, and lack of market structure (D’Este et al. 2012). In other words, the change required in prevailing institutions and institutional arrangements in the service ecosystem represents an important source of innovation barriers.

In a particular organizational field—as the service ecosystem of eRX in our study—institutional logics provide the key organizing principles for the ecosystem (see Friedland and Alford 1991) but also a key source of imbalance (Verleye et al. 2017). As especially radical innovations require changes in a range of “rules and norms”, and thereby practices by a number of industry players whose interests may not be harmonious with each other, tensions may emerge throughout the innovation institutionalization process (Geels and Schot 2007). These tensions can be viewed through the lenses of competing institutional logics (see e.g. Ruef and Scott 1998; Fuenfschilling and Truffer 2014). Research has also highlighted the importance of dominant logics and shifts from one logic to another (e.g., Thornton and Ocasio 2008). Competing logics might either co-exist over a longer period of time, raising “issue fields” where these logics are debated among actors such as industry professionals, associations, company representatives, and policy-makers (Zietsma et al. 2017). However, these contradictions might be resolved via relying on collaboration between the actors possessing those competing logics (Reay and Hinings 2009), or those logics might be reconfigured over time into a new convergent institutional logic among actors (Fuenfschilling and Truffer 2014). Verleye et al. (2017) argue that in complex health care ecosystems, competing institutional logics such as ‘business logic’ and ‘patient care logic’ cannot be perfectly balanced, but value cocreation can be achieved by securing the needs, wants, and interests of each actor to a reasonable degree by advancing communication, accountability, engagement, and responsiveness by ecosystem actors.

The tensions related to competing institutional logics in service ecosystems may be viewed as barriers to the innovation process, but also as stimulants of development (Vaaland and Håkansson 2003). Conflicts and tensions may arise especially between heterogeneous actors who often operate according to different logics, such as in the case of complex public health care ecosystems (Verleye et al. 2017). According to Driessen and Hillebrand (2013), stakeholders related to innovating can be divided into "market stakeholders" (comprising customers, competitors, suppliers, and retailers) and "non-market stakeholders" (comprising regulators and special interest groups), and differing perspectives i.e. logics may result in tensions.

In sum, a prerequisite for successful innovation is that it becomes institutionalized. Therefore it becomes essential to understand what facilitates successful institutionalization, and what kind of tensions and competing institutional logics might arise that create barriers to institutionalization.

## 22.5 Case Study: Development and Diffusion of the Electronic Prescription System in Finland

This chapter reports an extensive, complex multi-actor case study investigating the development and diffusion of the Electronic Prescription in Finland. The case captures the full innovation process of the eRX system in Finland during 2001–2016; covering the process from early visioning to full scale diffusion, and the role of a range of diverse actors in institutionalizing the innovation within the service ecosystem. Main sources of data for the case study comprise interviews, public report and studies, research publications, and media materials (for information on study methodology, see Appendix A). The case represents a relevant area of eHealth worldwide: different Electronic Prescription Systems have been tested or implemented in several European countries and in the United States, and digitalization of prescribing is a part of the national eHealth strategy in many European Union (EU) countries (Samadbeik et al. 2017).

The innovation in this case a new way of prescribing and dispensing medicine: an *electronic prescription* (eRX) is a digital prescription for pharmaceuticals that a physician writes up and signs electronically and enters in the national Prescription Centre where pharmacies and other health care professionals can access it, replacing a paper prescription handed to the patient (Ministry of Social Affairs and Health 2015). The innovation process involves developing the technical specifications for the IT system, and also new practices of prescribing and dispensing medicine.

The eRX represent a major shaping of institutions and institutional arrangements as it is an 'irreversible' intervention in the large, multifaceted service ecosystem comprising a network of hospitals, doctors, clinics, pharmacies, authorities, commercial executors (e.g., software vendors) and patients (Salmivalli 2008). For the eRX to become functional, there was a requirement of simultaneous change in

legislation, professional practice, information system protocols as well as practices of citizens, i.e. patients. The main actors or the eRX therefore include various governmental (e.g. Ministry of Social Affairs and Health and Social Insurance Institution), public (e.g. health districts and centers), and private actors (e.g., pharmacies, system suppliers and software companies).

Next sections analyze more in detail the service ecosystem, the development and diffusion process of the eRX, and challenges in the institutionalization of the new system.

### 22.5.1 Ecosystem Actors Shaping the Institutionalization in the eRX Case

The Finnish health care system resembles those of other Nordic countries and the UK in the sense that it covers the whole population and its services are mainly produced by the public sector and financed through general taxation. A distinctive feature of the Finnish system is the National Health Insurance scheme, which partly reimburses medications prescribed by a doctor, private sector examinations and treatments performed or prescribed by a doctor or dentist (Häkkinen 2005; Salmivalli 2008). The Finnish system is exceptionally decentralized: local authorities around the country are responsible for organizing primary and specialist medical care for residents of the municipality (Häkkinen 2005). Public health care is supplemented by private health care actors, especially in the larger municipalities. Medicines may be sold to the public only by pharmacies and subsidiary pharmacies. There were 810 privately-owned pharmacies or subsidiary pharmacies in Finland in 2016 (Association of Finnish Pharmacies 2016).

The process of developing the eRX system in Finland involved diverse actors. The actors that mainly influenced the specification of the eRX system included The Social Insurance Institution (SII) and the Ministry of Social Affairs and Health (hereafter 'Ministry'). The Ministry was responsible for steering the national development of healthcare IT and prompted the development process in motion. Their role was to develop the strategy, prepare the legislation, and define the system architecture as well as the necessary data structures for the eRX. SII as the national insurance institution was designated as the technical producer and administrator of the system. There were also a range of municipal and governmental associations and institutes involved, with the task of coordinating particular phases of the project. The primary private actors involved included technology experts such as IT and software companies and system developers whose responsibility was to develop and deliver technology and software to health care service providers and pharmacies.

Actors representing the professions and user groups affected by the eRX system were health service provides, pharmacies, and patients. The health care units and pharmacies were assigned into the projects to develop and pilot the eRX system and later to develop guidelines for its deployment and integration into existing systems

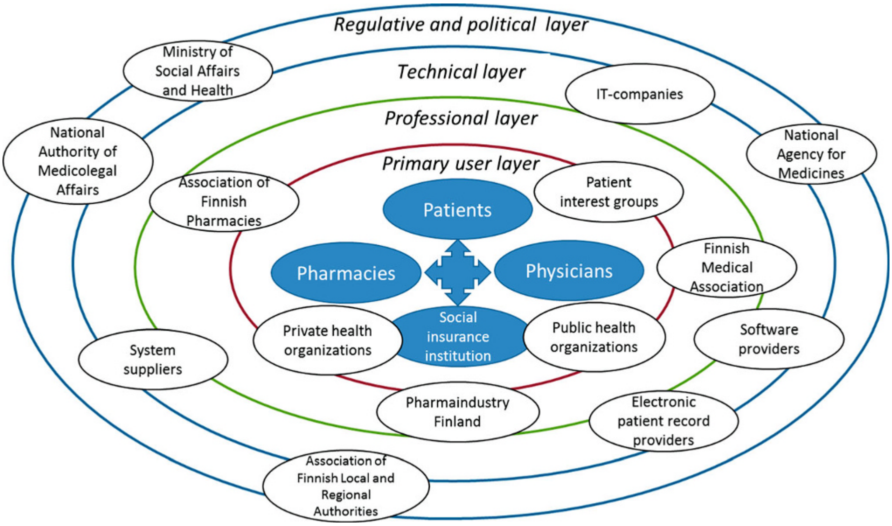


**Fig. 22.1** Service ecosystem actors affecting the development and diffusion of eRX

and service processes. Also various associations and interest groups were active along the innovation process, assessing the project and giving statements on the perceived benefits and problems of the planned system from the perspective of a particular interest group. Finally, the diffusion of eRX was dependent on the numerous pharmacies, health care units and doctors who were supposed to renew their systems and service processes to accommodate to the new prescribing system. Also individual patients affected the pace of the diffusion as they could, until 2016, refuse to take eRX (Ministry of Social Affairs and Health 2015).

The eRX case thus illustrates a very complex constellation of diverse actors consisting of versatile market and non-market stakeholders (Driessen and Hillebrand 2013) all of whom affect the institutionalization of the innovation throughout the innovation process. Together these stakeholders constitute a service ecosystem, representing different types of layers in this system: the primary user layer; professional and industry layer, technological layer, and finally regulative and political layer (Fig. 22.1).

## *22.5.2 The Process of Development and Diffusion of the eRX*

The eRX innovation process advanced through four main phases (Fig. 22.2) (see also Aarikka-Stenroos et al. 2017 for a more detailed case description). *Initial goal setting* for the eRX took place during 2001–2002, started by the Finnish Ministry of Social Affairs and Health, which anticipated eRX would bring far reaching benefits

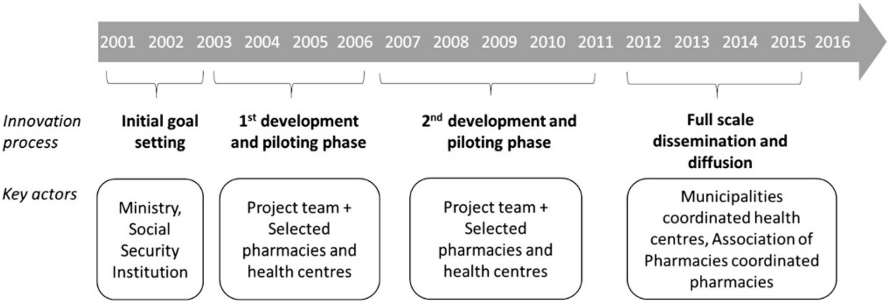


**Fig. 22.2** The process of eRX development and diffusion and key actors in each phase

on the national level. The Ministry assigned the Social Insurance Institution (SII) and the National Agency for Medicines (NAM) to develop an initial plan for a new national concept that was published in 2001.

The *first development and piloting phase* for the eRX system took place between 2003 and 2006. The Ministry assigned four units of health care organizations and a few pharmacies in different regions to participate in developing and piloting the concept. Aside from the IT-firm conducting system development, project participants did not get any financial compensation for their input. The project was mainly advanced by influential individuals in health districts who were personally convinced by the Ministry's vision and wanted to bring their municipality to the forefront of eHealth development. The general opinion among health care professionals did not favor the development plans, demonstrating the divergence in the institutional logics at the time. As privately owned businesses, pharmacies feared the costs of investments the eRX system would require, and they perceived the traditional system of dispensing medicines as less complicated. Doctors resisted changing their daily practice and did not want to spend time on learning new IT-programs. Health centres in municipalities were concerned about their budgets as new systems would require investments in new it-infrastructure and training personnel. For pharmacies and health centres the anticipated benefits of eRX, such as reduced medication errors, seemed distant. Because of these challenges, the pilot project advanced very slowly: by the end of 2004 only two out of the four piloting health care units had implemented the eRX integrated into electronic patient record (Salmivalli 2008). The pilot was terminated in 2006.

The *second development and piloting phase* (2007–2011) was led by the SII. This time the development was spurred by a law issued by the Finnish government in 2007 that commanded eRX to be deployed nationally by 2011. The SII employed an IT system provider to construct the technical system, and later assigned the piloting and refinement of the developed system to two project teams, comprising health centres, pharmacies, and software companies. According to many informants, the sheer volume of participants made the development very complex. Each groups of actors viewed the development project through their particular institutional logics.

For example, the SII sought to ensure that the system had a good fit their health information archive; municipalities preferred an eRX system that would fit with their current IT-infrastructures; software companies considered only the technological aspects; and physicians wanted to have an easy user interface. It became evident that a law making eRX compulsory was not enough to secure different actors' compliance on project level functions, but it was necessary to involve them more closely to the development and make sure that everyone's views were heard. This was done by organizing regular events and meetings with representatives of different actor groups. The first fully operating eRX service was finally launched in 2010.

*Full scale dissemination and diffusion* of the eRX took place between 2012–2015. The law obliged all health care units and pharmacies to adopt electronic prescribing by April 2014. The practical challenge was that each health center and pharmacy in Finland had to adapt or renew their IT-infrastructure and service practices to deploy the eRX system. Especially health centers struggled with this: they had insufficient competence in dealing with IT-suppliers and self-governed health districts resented a system that was imposed nationally. The dissemination process was facilitated by assigning actors closer to each user group to coordinate the deployment process; municipal hospital districts for health centers, and the Association of Finnish Pharmacies for pharmacies. These organizations helped service providers put the needed practices and procedures in place. Eventually, a broad-based convergence of institutional logics across actor groups was witnessed as the service ecosystem gradually begun to view the eRX as the norm instead of disruption, despite maintaining some differing views on its practical implementation. Today, all pharmacies and close to every health service organization have joined the eRX system (Ministry of Social Affairs and Health 2015). The main events and challenges in this process are summarized in Table 22.1.

### *22.5.3 Barriers for the Institutionalization of the eRX*

As the story of the eRX (see Table 22.1) reveals, the institutionalization of the eRX was complicated by lack of converging logics and thus shared commitment to the goal and the process of pursuing it. Different actors in the eRX service ecosystem held divergent institutional logics that affected their perceptions of the usefulness of eRX. The interviewees noted that in the beginning of the project, different stakeholders shared the mutual understanding that developing the eRX was in principle a worthy cause. They recognized many benefits electronic prescribing could create on the national level, such as rationalization of medication and medication costs, bringing health care up-to-date, and increasing the productivity of health care generally. The system could increase efficiency in prescription handling, for example, reduce telephone prescription queries from pharmacies to physicians. Another perceived benefit was the potential for improving the patient quality of care as an integrated system would make it easier to detect overlapping medication and thereby reduce medication errors and adverse drug interactions.

**Table 22.1** Key events and challenges during the eRX development and diffusion process (see also Aarikka-Stenroos et al. 2017)

| 2001–2002: Initial goal setting | 2003–2006: First development and piloting phase | 2007–2011: Second development and piloting phase | 2012–2015: Full scale dissemination and diffusion |
|---|---|---|---|
| • The Ministry wanted to see Finland adopt eRX to improve productivity and patient safety in health care<br>• The Ministry assigned SII and NAM to explore the potential for eRX<br>• Based on the report, the Ministry made a decision for developing the eRX | • The Ministry started a project to create the basic specification for the system and invited four municipalities to take part in pilot projects<br>• The participating actors did not receive financial incentives and the pilot projects were under-resourced<br>• The eRX plan affected a range of diverse actors that each had their own agenda and differing interests<br>• For pharmacies and health organizations, there was no business profit to motivate development work<br>• The project was driven by individuals who were personally motivated and believed in the vision of the Finnish eRX<br>• The piloting did not spread far enough to show evidence on the benefits of the system to different stakeholders | • The Ministry issued a law to oblige the development of the eRX<br>• SII was given the operative lead of the project<br>• Developing a fully functioning system required resources of diverse actors<br>• Inertia and suspicion towards the eRX system in pharmacies and health centers<br>• Actors had conflicting interest as municipalities had different IT-infrastructures in use which made it difficult to compromise<br>• Lack of holistic coordination of the process as the Ministry was very far from the practical work and other actors focused on their own agendas<br>• Participants were unsure about the benefits of the system for them<br>• SII organized meetings with different actor groups to commit them to the eRX | • Legislation imposed deadlines for full implementation of eRX<br>• Resentment in pharmacies and health centers that lacked IT-resources and disliked the imposing of a national system<br>• Deployment in health centers and pharmacies was coordinated by municipal hospital districts and the Association of Finnish Pharmacies<br>• SII organized seminars and training sessions to promote the eRX<br>• Nearly all pharmacies and health centers had adopted eRX by end of 2014, showing the convergence of logics across actor groups |

However, these expected benefits of the eRX seemed too distant to motivate the stakeholders to change their practices. A major source of tensions between the stakeholders was that many of the *costs would be borne by one group of stakeholders* (e.g. public and private health care providers, pharmacies), while the *benefits would*

*be realized for other stakeholders* (e.g. patients, the society at large). Thus, in this case there was a clash between market logics and public welfare logics. The organizations participating in the pilot phase did not receive any financial incentives for participation: rather, they were expected to allocate resources for the pilots. Throughout the project, there was also confusion about who should cover the costs of transitioning to eRX. Individual stakeholders such as pharmacies and health care providers did not really expect any financial savings from the system, but on the contrary, they assumed that eRX would create more costs in terms of extended need of IT personnel and the upgrading of existing systems. Furthermore, *while the costs of the project were to be borne in the beginning of the project, the potential benefits would only realize in the long run*: the generation of any actual benefits would require that a significant proportion of all prescriptions were electronic, and as long as two systems were in operations (one for the paper prescriptions and one for eRX), the full scale benefits could not be achieved. Instead, the costs of both systems were running from the beginning. In general, many of the stakeholders shared the stance that the transition from paper prescription to eRX did not provide any great benefits, so the strong motivation to push and facilitate institutionalization was absent.

Evidently the key barrier for the eRX institutionalization process was the *divergence of logics held by public and private actors reflected in the different agendas, values, and beliefs*; this brought on conflicting interests regarding the eRX. The main driver of the development work during the second Pilot phase, the Social Insurance Institution, wanted the new system to support its other data archive systems; and the IT and system suppliers were only concerned with the technology aspect of the eRX. Pharmacies and health centers in turn considered the practical hassle and cost of changing their IT and even physical infrastructures, and training their staff to adapt to the new service and prescription handling practices. There were also more profound barriers in the beliefs held by different professional communities; for example, professional associations of doctors and pharmacists had a generally negative stance towards outsiders imposing changes in the current practices, and some influential individuals even saw the eRX as a potential step towards online trade of medicines, something that was deeply resented by pharmacies.

It was also apparent that the leading actors driving the innovation process in the emerging service ecosystem initially did very little to create a common ground and converge different actors' viewpoints and logics closer together. During the first phases of the process, *the end-users' perspectives were not taken into account to any considerable extent*. Consequently, in the piloting phase, the eRX was not very attractive for the key end-user adopters, i.e. physicians, although their acceptance was a critical factor in the early phases of the institutionalization: physicians could choose between paper and eRX format during a long transition period which meant that they were the main gatekeeper for the wider diffusion of the eRX. Physicians who did not perceive any significant advantage in using eRX would not easily choose the new format in their busy daily practice. A factor contributing to their

reluctance was that the first software versions were rather cumbersome to use: tens of mouse clicks were required to log into the system and to write a prescription.

Using the eRX was at first inconvenient also for the patients, as in the piloting phase, the eRX could be collected only in certain pharmacies that often were far away from the health center where the prescription was written. Patients therefore preferred a traditional prescription that they could collect in their nearest pharmacy. In practice, these inconveniences on the level of daily practices of primary end-user adopters overruled the potential benefits that could be gained on the society level, over a long period of time.

## 22.6 Discussion and Implications

This case study illustrated a longitudinal process of a major health service innovation—the electronic prescription—that was developed and diffused in Finland during a period of almost 15 years. The case study highlights in two key points: First, the eRX innovation process required involvement and adaptation by diverse actors in multiple service systems, but was significantly delayed and nearly disabled by these actors' competing institutional logics that prevented them from committing to the project and hence adopting new practices related to prescribing and dispensing medicines. The innovation process was initiated and led by public actors that, due to their own institutional logics, sought long-term, macro level benefits such as rationalization of health care and keeping Finland at the forefront of eHealth. On the other hand, the actors whose resources were needed to make the change happen followed different institutional logics and were therefore more concerned with more micro-level, proximate goals such as technology development (IT-service providers), business logics (pharmacies), professional service practices (doctors), resourcing and cost control (municipalities), and convenience (patients).

These findings are in line with earlier notions that that diverging logics are a key source of tensions disrupting value co-creation in health care ecosystems (Verleye et al. 2017) and largely hinder collaboration for innovation by inducing competing or conflicting interests and goals, or different prioritizations among actors (Öberg and Shih 2014). Therefore, it is crucial for successful innovating to reach sufficient level of convergence in the logics among all actors that play important roles in the development and commercialization in the overall service ecosystem (Öberg and Shih 2014; Vargo et al. 2015).

Second, our analysis revealed challenges posed by competing and even conflicting institutional logics that that needed to be overcome for the eRX to gradually become institutionalized in the broader service ecosystem. These findings hence accentuate the importance of the question how convergent institutional logics in service ecosystems are created. Existing research on institutional logics suggest that actors resolve the contradictions in competing logics in two ways. Actors can retain the differences in logics, but learn to live with the difference it through collaboration (Reay and Hinings 2009) or stabilization of two co-existing logics as

Ruef and Scott (1998) demonstrated in hospital reform context (medical-professional logic vs. administrative-managerial logic). In service ecosystems, this would mean that a group of actors representing a particular 'layer' or 'sub-system' to the broader whole would recognize the differences in competing logics, while still enabling coordination in the service ecosystem level. We found that visionaries and developers need to sufficiently understand the logics of end-users and key disseminators of innovation: in the eRX case, actors driving or managing the innovation somewhat failed to recognize and acknowledge different logics in the front part of the innovation process, but at the later part involved a larger set of actors in collaboration, thereby facilitating the deployment and diffusion of the innovation. Previous research provides also evidence of cases where institutional logics have been blended or reconfigured over time to new, shared logics among actors that previously held competing logics (e.g. Fuenfschilling and Truffer 2014). In the context of the eRX, one can argue that through increasing communication and engagement the key stakeholders over time converged towards to a partially shared view of the benefits and necessity of the eRX system despite maintaining some differing notions of its practical implementation, hence enabling the service ecosystem to function and create value in a better way (cf. Verleye et al. 2017).

The main contribution of this study to service science literature is to highlight the development and diffusion of major innovation as a process of institutionalization, analyzing in particular how competing institutional logics challenge this process in service ecosystems. This empirical illustration complements recent S-D logic based discussions on the role of institutions in innovation processes (e.g., Vargo et al. 2015; Koskela-Huotari et al. 2016; Wieland et al. 2016; Wallin and Fuglsang 2017). As Wallin and Fuglsang (2017) note, efforts for institutional change plays a crucial role in the service innovation process, but have not thus far received sufficient attention in service research. This study also demonstrated the importance of studying multiple layers of the service ecosystem (Fig. 22.1) as together they host a range of stakeholders that gradually work towards or against institutionalizing the innovation. This notion contributes to innovation research that has typically focused on examining merely one layer at a time, such as end-users (e.g. Harrison and Waluszewski 2008) or technological infrastructures (Rohrbeck et al. 2009). In the studied case, successful adoption and diffusion of the service innovation was set back by overemphasizing the logic of technological effectiveness and the perspective of technological stakeholders. However, the success of the eRX was not only about deploying new information systems, but changing the everyday processes and norms of a range versatile actors, i.e. changing prevailing institutions. Failure in such caused years of delay in the studied innovation process. Our research brings new insights also into research on technological transformations by examining a service innovation context (Geels 2002).

Our case also shows that sometimes the innovation has the potential for providing benefits for a wide range of stakeholders but due to the extent of changes needed, as well as lack of vision or unclear short-term benefits, the majority of the key actors are unable or even unwilling to commit to the new regime, but a change agent from higher layers of the innovation ecosystem—a regulative body—needs to force the

action. As ecosystems comprise interdependencies between actors, technologies and institutions (Aarikka-Stenroos and Ritala 2017; Verleye et al. 2017), it is important to recognize which parts of the ecosystem need to actively facilitate the change and engage other actors along. Our research demonstrates that some stakeholders in the ecosystems are more equipped to facilitate the institutionalization process, pinpointing the need of effective network management (Aarikka-Stenroos et al. 2017). Wallin and Fuglsang (2017) found that building legitimacy for the proposed innovation by mobilizing powerful players in the field is critical it enables modifications of institutional arrangements that protect the established health care regime. Similarly, our findings highlight the important role of supporting actors, such as policy makers and regulators, in influencing other actors in their decisions or abilities to pursue the innovation goal, and thereby facilitate the gradual convergence of logics in the service ecosystem.

The key managerial implication of this study is that innovating actors should focus not only on the process of product or service development and the immediate partners involved, but take into consideration the entire service ecosystem with versatile layers of stakeholders that may critically facilitate or hamper the institutionalization of the innovation in the long run. Mapping and understanding the institutional logics of such stakeholders and how they influence stakeholders' actions is needed to foresee potential barriers to the innovation diffusion. As the long term success of an innovation is determined by its ability to become institutionalized (cf. Vargo et al. 2015), facilitating the convergence of institutional logics of multiple ecosystem actors should begin at the very early stages of the innovation process.

As contemporary innovation environments often involves multiple stakeholders and extensive ecosystem contexts, the relevance of coping with and facilitating diversity in logics, priorities and goals is increasing. Thus, future research should examine how innovations are enabled, facilitated, and constrained in extensive service ecosystems, despite the methodological challenges originating from such diversity.

**Acknowledgements** The authors would like to thank Dr. Lauri Salmivalli for commenting on the previous version of the manuscript.

## Case Study Methodology

This study applies a single case strategy as it aims to investigate in detail an extensive, complex multi-actor case study on the development and dissemination of electronic prescription in Finland. Case studies are considered suitable for examining complex phenomena that are not easily separable from their context (Halinen and Törnroos 2005). In this study, the case consists of the development and diffusion process of the Finnish eRX within service ecosystems that comprise different kinds of actors that are engaging in, or affected by the innovation process.

The eRX case covers the time period of 2001–2016. Main sources of data for the case study comprise interviews, public report and studies, research publications, and media materials. Thematic interviews were conducted with a range of key stakeholders involved in the innovation process. The interviews revolved around their interests and goals with regard to the eRX, and perceptions on the critical events in the process. Due to the public nature and high societal relevance of the eRX project extensive media and open archive data on the case was available. The data comprise the following:

– 18 interviews with key actors in the process, conducted in 2010, 2012, and 2016
– 9 sets of seminar presentation materials by different actors
– 3 extensive, official pre-study and evaluation reports on the pilot studies
– >25 publications in professional magazines, newspapers and websites
– 8 academic theses

By collecting different types of data along the development and commercialization process of electronic prescription and from different actors, we increased data triangulation (e.g. Flick 2004).

The analysis begun by developing an overview of the case by identifying the key actors involved and their activities in the innovation process. We also analysed what types of goals and perceptions each type of actors had with regard to the eRX. Next we identified the critical events along the years-long innovation process and sought for reasons for such event to have occurred, to form interpretations of the process of emerging convergence of institutional logics by the actors.

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# Chapter 23
# Innovation in Sociomaterial Practices: The Case of IoE in The Healthcare Ecosystem

**Cristina Mele and Tiziana Russo-Spena**

**Abstract** The chapter contributes to the development of service science by offering an integrated view of human systems and technical systems in a practice-based approach. Existing ways of doing, knowing, and connecting are changing, and new practices are emerging due to the IoE. Social and material reality fundamentally consists of practices which are produced and reproduced through everyday actions. Moving innovation into the practice realm means going from the outcome or objects to the very process—that is, innovating as a verb, in reference to the emergent process. The Healthcare ecosystem provides evidence on how humans and machines together compose complex adaptive service systems that affect and are affected by new sociomaterial practices. In such context innovating is framed as a texture of practices such that the set of practices rests on other practices performed by actors who integrate material and social resources (e.g., knowledge, tools, languages, artefacts) to improve service provision and actors' well-being. Multiple sociomaterial connections across actions arise at the cross-points of actors' interactions and resource integration, revealing a broader picture that can depict service innovation complexity more accurately.

**Keywords** Internet of Things · Internet of Everything · Service ecosystem · Sociomaterial practices · Service innovation · Health

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_23

## 23.1 Introduction

Thanks to the advent and dissemination of smartphones, tablets, and smart devices, the number of connectable devices has significantly increased, reaching more than 16.3 billion in 2015 (about 2.2 devices per person). This level likely will reach 26.3 billion connected devices (3.4 per person) by 2020, including wearable devices that are predicted to account for a $34 billion market by that year (Cisco 2016). This growth in connected smart technologies has given rise to the Internet of Things (IoT) (Ashton 2009; Atzori et al. 2010), a term used to describe machine-to-machine interactions (M2M) that provide novel applications and services, through "a system of uniquely identifiable and connected constituents capable of virtual representation and virtual accessibility leading to an Internet-like structure for remote locating, sensing, and/or operating the constituents with real-time data/information flows between them" (Ng and Wakenshaw 2017, p. 4).

An even more recent trend is the Internet of Everything (IoE), which shifts the focus away from pure technology or devices and toward users and their technology-enabled connections. The IoE is a broad term that encompass connections among four dimensions: people, things, data and processes; it connects the unconnected "to make networked connections more relevant and valuable" (Bradley. et al. 2013: pag 2). The resulting networked connection of complex systems relies on different types of links (e.g., M2M, machine-to-people, people-to-people). In turn, the IoE might create unprecedented opportunities for business and society, due to the value of this increased connectedness as everything comes online (Bradley. et al. 2013; Spohrer 2017).

Although growing IoT literature addresses many technical issues (Vermesan and Fries 2014), business scholars have only just begun to participate in the analyses (Ng and Wakenshaw 2017). Service innovations, enabled by the confluence of big data, mobile solutions, cloud computing, cognitive computing, and the IoT/IoE, attract significant attention because they offer promising ways for actors to innovate (Demirkan et al. 2015; Ng and Wakenshaw 2017; Spohrer 2017). However, no studies have considered the impact of new digital and cognitive technologies on complex systems interactions. Service scholars thus must find ways to explicate how digitisation functions as "a new layer of connected intelligence that augments the actions of individuals and organizations, transforms data, and incorporates digitally empowered systems into our lives" (Demirkan et al. 2015, p. 734). Some authors suggest that new devices do not impose themselves on the new adopter thanks to their inherent innovativeness (Nicolini 2010). In this context, innovation is more than the development of new outcomes (Maglio and Spohrer 2013; Maglio et al. 2015; Mele et al. 2017); there is the need to recognise the social waves of new technologies in terms of the new social practices that they enable (Greengard 2015; Nicolini 2010; Vermesan and Fries 2014).

To move beyond a traditional view of service innovation, in which service systems produce new artefacts, products, or services, the approach in this study is more sensitive to social, cultural, and technological issues that arise within service

ecosystems. The focus shifts from individual devices to the sociomaterial practices enabled by the application of the IoE in healthcare, a critical service research priority (Ostrom et al. 2015), along with co-creation practices (McColl-Kennedy et al. 2012, 2017). A full understanding of the resource integration process that occurs among actors requires abandoning a logic of separation (e.g., healthcare providers vs. patients) and adopting a logic of togetherness: a "linked system of suppliers of products with a value constellation of other co-creating actors, forming a health ecosystem" (Joiner and Lusch 2016, p. 32).

In accordance with a practice-based approach (Gherardi 2006), existing ways of doing, knowing, and connecting are changing, and new practices are emerging in the healthcare ecosystem due to the IoE. Social reality fundamentally consists of practices (Schatzki et al. 2001), which are produced and reproduced through everyday actions. "Practices" in turn are constitutive of the sociomaterial world (Orlikowski 2002), in which human agency is shaped by and also produces, reinforces, and changes structural conditions in a recursive process of reproduction and transformation. Moving innovation into the practice realm means going from the outcome or objects to the very process—that is, innovating as a verb, in reference to the emergent process (Mele et al. 2017; Russo-Spena and Mele 2016). Here, innovating can be framed as a texture of practices (Mele and Russo-Spena 2017), such that the set of practices rests on other practices performed by actors who integrate material and social resources (e.g., knowledge, tools, languages, artefacts) to improve service provision and actors' well-being. Multiple sociomaterial connections across actions arise at the cross-points of actors' interactions and resource integration, revealing a broader picture that can depict service innovation complexity more accurately.

This chapter thus contributes to the development of service science by offering an integrated view of human systems and technical systems in a practice-based approach. Humans and machines together compose complex adaptive service systems that affect and are affected by new sociomaterial practices. To present these insights, the next section contains a review of service system and service ecosystem literature, with a focus on social and technological aspects. After outlining the system perspective in a healthcare context and the e-health field, this chapter introduces the practice-based approach to innovation and sociomateriality. The next section presents the methodology, followed by the findings and a discussion and implications to conclude.

## 23.2 Service Systems

A system approach regards a situation holistically, rather than from a reductionist perspective, and recognises that relationships or interactions among elements are more important than the elements themselves for determining system behaviour (Mele et al. 2010). A system can be defined as an "entity which is a coherent whole" (Ng et al. 2009, p. 379), such that a boundary drawn around it can distinguish

internal and external elements and identify the inputs and outputs entering into and exiting from the entity. This boundary divides the system from its infinitely complex environment. The interior of the system thus offers reduced complexity and facilitates inner communication, by selecting only a limited amount of all information available. Although the idea of complexity has always been implicit to systems, it became more prominent through theoretical developments (Flood and Carson 2013). The elements that characterise complexity include the variety of the system's elements, the variability of the relationships among them, and the quality of the relationship between the system and the environment. As influenced by Morin (1984), the complexity perspective was well defined by a physicist (Capra 1996, p. 4), who explained: "The more we study the major problems of our time, the more we come to realise that they cannot be understood in isolation. They are systemic problems, which means they are interconnected and interdependent".

In management and marketing literature, complex adaptive systems have been addressed by Holbrook (2003) and Wollin and Perry (2004), who suggest that any one interaction can affect any other. Notable contributions also emerge from service science, emphasising the role of systems (Demirkan and Goul 2006; Spohrer et al. 2007; Maglio and Spohrer 2008). Researchers thus express renewed interest in "using a systems approach towards the understanding of internal structures (intra-entity service) and external structures (inter-entity service) that exist to support the value co-production and co-creation process" (Ng et al. 2009, p. 379). In particular, service science seeks a theory of service based on service systems, defined as dynamic value co-creation configurations of people, technologies, shared information (language, value, measures), and other resources (Maglio and Spohrer 2013). By interacting through value propositions, service systems exchange service for service (Vargo and Lusch 2004). The contemporary notion of "service" also implies an activity (or series of activities) in which interacting actors utilise various resources to develop solutions to certain needs. Information and communication technologies (ICT) have a crucial role, by enabling the development of smart service systems "designed for a wise and interacting management of their assets and goals, capable of self-reconfiguration (or at least of easy inducted re-configuration) in order to perform enduring behaviour capable of satisfying all the involved participants in time" (Barile and Polese 2010, p. 31). These intelligent self-service systems also are augmented with instruments (to monitor users' behaviours) and interconnected (in patterns of connections) (Demirkan et al. 2015).

## 23.3 Service Ecosystem

Service science and the service-dominant (S-D) logic have widened the focus to service ecosystems, a metaphor that is useful for describing how networked systems work (Kearse et al. 2012; Lusch and Vargo 2014). In contrast with business ecosystems (Iansiti and Levien 2004) or a firm-centric view, the S-D logic regards all actors (social and economic) engaged in the exchange as service-providing,

value-creating enterprises (Wieland and Wallenburg 2012). A service ecosystem includes heterogeneous service systems, which interact on the basis of their shared intentions (Polese et al. 2017; Taillard. et al. 2016) to achieve common goals, such as mutual value creation, by creating new solutions. The ecosystem metaphor describes the connections among the self-adjusting systems of actors that are able to integrate resources and are guided by shared institutional logic (Lusch and Vargo 2014).

Service systems act as resource integrators through the service ecosystem, striving to achieve a better match (Gummesson and Mele 2010). Each system emerges and develops as a unique combination of resources, and it contributes to the ecosystem in a unique manner. The role that one actor plays in a particular service ecosystem is not the same as that of any other actor. The value-creation potential of a service system arises from its core competences and distinctive resources, as well as its ability to match and to insert itself into an ecosystem to ensure its success and evolution (Gummesson and Mele 2010). This process is influenced by two factors: social relations that affect actors and the ICT patterns and tools that foster actors' participation (Lusch and Vargo 2014; Mele. and Polese. 2011).

The concept of a social net stresses actors' connections and social relationships. The complexity in an ecosystem can be exploited to encourage performance and idea convergence, which reduces potential conflicts. A reserve of ideas, knowledge, and intuitions is available to be exploited. Complexity imposes a choice. In activating relationships, the choice by the service system influences its generation and evolution. Service ecosystem formation is a process of emergence, in which the development of shared intentions enables collective agency. As actors move from their own individual intentions to form the "we" that is essential for service exchange, they engage in interactions and participate in the formation and evolution of the ecosystem (Taillard. et al. 2016).

An ICT net instead pertains to the ways people engage with computing to execute processes and to the semantics that individuals and machines establish together in new ways (Demirkan and Goul 2006). It enables connections, as in the IoT case. The IoT can decompose and reconfigure the system, which affects its digital materiality and its connectivity (Ng and Wakenshaw 2017). It increases the digitalisation of information, making it easier to store, access, and share data (Ng and Wakenshaw 2017). It acts by increasing the liquification (i.e., possibility of dividing information from a physical object; Normann 2001) and density of resources available to the actor. In this sense, actors are interested in obtaining feedback from big data and smart devices to increase their resource access and thus enhance their well-being (Lusch and Vargo 2014).

The social net and the ICT net are interlinked; the latter supports the development of actors' interconnections, fostering relationships and the sharing of information and knowledge. A service system's key ability is to foster this integration of the social and ICT nets, through appropriate management of their links, within both a single service-system entity and across the service ecosystem as a whole (Maglio and Spohrer 2008; Maglio et al. 2009; Barile and Polese 2010).

The impact of ICT in such contexts must be considered when studying actors' interactions within the service ecosystem (Akaka and Vargo 2014). As Maglio et al.

(2006, p. 83) observe, “the challenge lies not simply in formally modelling the technology or organizational interactions, but in modelling the people and their roles as knowledge workers in the system”. This perspective emphasises institutions, or social norms (Williamson 2000), as central drivers of the actions and interactions that enable service innovation, as well as service systems (re)formation (Vargo and Lusch 2011). Vargo et al. (2015) suggest a practice approach to study how ecosystems form and reform through the enactment of practices. From an ecosystem perspective, the actions and interactions among actors continuously sustain and reproduce the system by socially constructing an institutional logic or schemas that influence activities and exchanges (Singh et al. 2011; Koskela-Huotari and Vargo 2016). The norms of social interaction and collective meanings contribute to create structures that can “manage” (or at least influence) the service ecosystem and increase its viability (Wieland and Wallenburg 2012).

## 23.4 A System View on Healthcare and e-Health

The system view has been well recognised in healthcare (Begun. et al. 2003; Rouse 2008). As Tien and Goldschmidt-Clermont (2009, p. 257) explain, “the design of a healthcare system must recognise the fact that it is actually a complex integration of human-centered activities that is increasingly dependent on information technology and knowledge”. Such a service system is an arrangement or rearrangement of three elements: people (who exhibit behaviours, values, knowledge), processes (e.g., collaboration, customisation), and products (e.g., software, hardware, infrastructures). Some initial attempts to apply the service ecosystem view to the healthcare context acknowledge that healthcare is a complex service system, and “healthcare services are carried out with knowledge-intensive agents or components which work together as providers and consumers to create or co-produce value” (Tien and Goldschmidt-Clermont 2009, p. 257).

In a mainstream view of healthcare, the patient is a passive actor, separated from the service provider, according to a strictly dyadic perspective (Osei-Frimpong et al. 2016). The provider is the only subject with experience, knowledge, and a creative and innovative mind and thus is the source or creator of value; the patient is a value recipient and destroyer, with scant knowledge (Joiner and Lusch 2016).

The S-D logic (Vargo and Lusch 2004) suggests moving beyond this separation between service provider and customer, to address patients’ engagement and involvement (Joiner and Lusch 2016). In the S-D logic, multiple actors are co-creators and resource integrators in value processes; each actor uses its applied knowledge and skill to provide benefits to another part and to itself (Lusch and Vargo 2014). As a resource integrator, the patient is no longer a passive beneficiary but instead has an active role in service innovation and value co-creation activities (Chan et al. 2010; Joiner and Lusch 2016). The customer possesses and integrates resources and skills to co-create value, so “Both the health provider and the consumer (or client or customer – rather than patient) are sensing and experiencing,

creating, integrating resources, and learning" (Joiner and Lusch 2016, p. 26). In developing an ecosystem perspective, the dyadic relationships linking supplier and customers get replaced by a value constellation of actor-to-actor (A2A) interactions—that is, a healthcare (service) ecosystem. Actors not traditionally regarded as part of the established health industry (family, friends, alternative healthcare providers) become part of the essential private resources network that consumers integrate to co-create value (Joiner and Lusch 2016).

Actors' dynamic interactions in the healthcare ecosystem in turn are co-creation practices that may have positive, negative, or both effects (Frow et al. 2016; McColl-Kennedy et al. 2012, 2017). According to Tien and Goldschmidt-Clermont (2009, p. 257), the healthcare ecosystem is an integrated and adaptive set of people, processes, and products: "an ecosystem of systems which objectives are to enhance its efficiency (leading to greater interdependency) and effectiveness (leading to improved health)". The complexity of the system can be managed through resource integration across physical, temporal, organizational, and functional dimensions, as well as actors' adaptation through monitoring, feedback, and learning dimensions.

The implementation of Internet-based technology has created e-health, an emerging field at the intersection of medical informatics, public health, and business e-health. It offers a new way of working, an attitude, and a commitment to networked activities to improve healthcare through the use of ICT (Pagliari et al. 2005). The prefixed "e" is not simply about technology, or "electronic", but rather "is a more broadly encompassing prefix that includes the enablement that information providers and the efficiencies occasioned by information technology and broadband telecommunication, all brought to bear on one of the most essential attributes of our existence, our health" (Meier et al. 2013, p. 2).

Recent developments in the IoT and IoE spur fresh ideas, and related devices, in the healthcare industry to overcome increasing costs and problems (Friess 2013). Smart health solutions imply the integration and collaboration of IoT technology to support service provision that features ubiquity and personification. Linking data from multiple sources (e.g., genomic, social, environmental, behavioural) and leveraging big data analyses help personalise cures and "change medicine" (Swan 2012).

The ways in which people connect to the Internet are changing radically, through their use of smart objects (e.g., glass, watches, shirts, lenses, bangles), which are designed to record, track, and exchange data with third parties through IoT and IoE technologies. The terms "wearable technology", "wearable devices", and "wearables" refer to electronic technologies that are incorporated into items of clothing and accessories that can comfortably be worn on the body. In terms of digital materiality, such devices refer "to what the software embedded in the physical object can do by manipulating the digital representation of the physical objects" (Ng and Wakenshaw 2016, p. 2).

Studies on wearables highlight the great potential of these devices, especially for self-awareness and self-diagnosis, due to three main features: (1) their interaction capabilities, such that commands imparted from the external environment can be executed by remote control systems and data processing (Swan 2012); (2) sensors

that can catch and record raw signals that in turn are analysed and processed as useful information that can be stored and transmitted to other devices or people; and (3) applications to solve problems.

Literature on e-health is in its infancy and mainly focuses on technical aspects. Technology is viewed both as a tool to enable a process/function/service and as the embodiment of e-health itself (Oh et al. 2005). Scholars focus on the opportunities provided by IoT platforms and cloud computing, in terms of extracting data and information from devices, which thus have a potential role in value co-creation processes. However, the ways practices are changing for actors in service ecosystems has not been investigated in depth. In summary, attention has been on the materiality (even in its digital shape; i.e., technology and artefacts), not on whether and how actors perform new resource integration, with a larger view that accounts for social and cultural contexts.

## 23.5 A Practice-Based Approach to Innovation and Sociomateriality

Practice scholars share the view that social reality is produced and reproduced through everyday actions (Gherardi 2006; Schatzki et al. 2001), and the social world is fundamentally composed of practices. A focus on everyday actions is not simply a focus on routines. The practices are constitutive of the sociomaterial world (Orlikowski 2002), in which human agency produces, reinforces, and changes structural conditions in a recursive process of reproduction and transformation. Practice studies note the challenges of the multifaceted nature of market and innovation phenomena, proposing a shift in focus to the social and material aspects that influence the structure and process of market creation and innovation. As Orlikowski (2007, p. 1437) argues: “The social and the material not only are considered to be inextricably related – there is no social that is not also material, and no material that is not also social” (see also Orlikowski and Scott 2008). Relations and boundaries between humans and technologies are not given or fixed but instead are emergent or enacted in practice (Orlikowski and Scott 2008).

The debate is fragmented among various group of scholars.

Scholars in the social learning and organisational research tradition (Brown and Duguid 1991; Dougherty 2004, 2012; Duguid 2005) offer insights into how innovation unfolds through on-going social accomplishments involving multiple interactions. Innovation is not just the result of deliberate activities that introduce discontinuities (Brown and Duguid 1991); it is a provisional and emergent process in everyday activities that is inseparable from actors’ participation in doing and knowing (Gherardi 2012). Knowing as a collective and social accomplishment is constituted and reconstituted as actors engage the world in practice (Gherardi 2012; Orlikowski 2002). By assuming a processual view, Gherardi (2006) highlights the need to look at interactions and connections in action and overcome the notion of

boundaries in favour of a constellation of interconnected practices. They introduce the term "texture of practice" to refer to complex social and material processes that extend the organisation's boundaries internally and externally and in which distributed knowledge gets activated by establishing connections in action that produce specific forms, within a situated social and material practice (Gherardi 2012; Orlikowski 2007).

With a view on how changes occur, innovation can be regarded as a collective that links knowledgeable actors (Russo-Spena and Mele 2016; Mele and Russo-Spena 2017). It ceases to be simply the product of a company's processes and becomes a set of co-creation practices, as collective actions and accomplishments (Russo-Spena and Mele 2012). The term "innovating" then should replace "innovation" (Mele and Russo-Spena 2015, 2017; Russo-Spena and Mele 2016) to reflect the dynamics of the process in practice. The focus is not on the individual or the organisation but instead on the "way of doing" that is embedded in a context of interlinked elements (Mele and Russo-Spena 2017; Russo-Spena and Mele 2016; Russo-Spena et al. 2017). Building on Gherardi's (2012) ideas of the wider connectedness of practices, Mele and Russo-Spena (2017) outline the concept of innovating as a "texture of practices", such that a set of practices rests on other practices that boundlessly interweave relationships, actions, and resources. The emphasis is on the social and material connections that occur among a group of actors—individuals, collectives, and organizations—that integrate and connect an array of resources (tools, knowledge, images, material objects), as well as on the contexts in which knowledge creation and sharing take specific forms for innovation to occur. The practices are connections (Gherardi 2012), sustained by on-going series of sociomaterial relationships in actions. Innovation emerges as collective actions and accomplishments in an interconnected context (Russo-Spena and Mele 2012; Russo-Spena et al. 2017), and innovators are carriers of changing practices who perform actions through the use and integration of multiple resources (i.e., symbolic, linguistic and material, and technological).

A practice perspective also has been promoted in studies within the S-D logic, addressing the links between social practices and institutional aspects (norms, rules, behaviour). This approach overcomes the divide between market innovation and technology innovation and locates institutionalisation (i.e., the process of change, disruption, and maintenance of institutions) as central to innovation (Vargo et al. 2015; see also Koskela-Huotari and Vargo 2016). Innovation is broadly conceptualised as "the co-creation or collaborative recombination of practices that provide novel solutions for new or existing problems" (Vargo et al. 2015, p. 70). The focus moves to the process and social structures that enable interactions among diverse organisations and actors and provide context for innovation to emerge and diffuse. In such a view, technology is more than a physical artefact, as it includes potentially useful knowledge that covers both intangible processes and methods, as well as physical devices (Lusch and Nambisan 2015; Vargo et al. 2015). Technology is both an operand resource (enabler and inherent component of services) and an operant resource (part of innovation itself; Lusch and Nambisan 2015). Inspired by the sociomaterial practice view of Orlikowski (Orlikowski 1992, Orlikowski 2000; see

also Orlikowski and Scott 2008), Lusch and Nambisan (2015) argue that technology refers not only to artefacts that convey embedded knowledge and skills but also the mechanisms of institutionalisation. In sum, the focus on practices has inspired innovation scholars to analyse social connections among actors, resources, and actions, as well as the social and material contexts in which these connections form (Lusch and Nambisan 2015; Mele and Russo-Spena 2017; Vargo and Lusch 2016).

## 23.6 Research Design

By leveraging a practice-based methodological approach (Gherardi 2012, 2015), this chapter reports an original investigation undertaken to gain new knowledge about the nature of practices and how they are changing, rather than creating and reflecting on new artefacts. Gherardi (2012) suggests that the methodological principle of "follows the practices" implies that researchers observe a situated practice and move up from it to the institutional order, or move down from it to the individual-in-situation, thus exploring a "connective web" (Nicolini et al. 2003).

To perform this analysis, we chose a multiple case study (Yin 2013) pertaining to wearable devices in healthcare, which constitutes a new service provision and innovation in the healthcare ecosystem. We followed a qualitative research approach, pursuing deep, detailed, and rich data collections to explicate complex issues and advance extant knowledge (Dubois and Gadde 2002; Gummesson 2005). An inherent, typical element of qualitative research is interpretation, which helps find meanings and reflects what the individual does in practice (Gummesson 2005). In addition to iterating between theory and practice, this process is iterative between what we knew and what we have learned.

In line with Tong et al. (2007), the investigation involved multiple, purposefully selected actors: users, doctors, hospitals, managers, patients, parents, and so forth. The carefully defined group of 43 participants, who ranged in age from 25 to 65 years, included only actors for whom the research problem has relevance and personal or professional significance. The data were collected through observation, interviews, observations, and immersion.

Specifically, the in-depth and semi-structured interviews took place in face-to-face and Skype meetings; they focused on participants' experiences and the meanings they derived. In these one-to-one interviews, the questions focused on participants' uses of wearables and new healthcare practices, prompting them to talk about their experiences (e.g., "Can you tell me about a situation in which you use wearables?", "How do you do it?", "What changes have you experienced?", "How do you live that experience?" "What does this mean?", "In what way do you get benefits?" "Why?" and "Which kind of benefits?"). Each interview took 30–60 min. The interviewer encouraged participants to talk about issues pertinent to the research by asking open-ended questions designed to explore their experiences, meanings, and personal and sensitive themes. The researchers also provided sufficient flexibility for respondents to introduce original or unexpected issues, which then could be investigated in more detail.

The interviews were recorded, listened to, and reflected on by both researchers independently. Supplementary data collections included preliminary analyses of reports and documents, in-depth study of usage-based contexts, and observations of the actors and their visible actions. The researchers read through the results several times and had multiple discussions to elaborate on their observations. The initial analysis sought connections among the key elements of IoE and emergent issues that the participants reported. In detail, this analysis focused on wearable features, the different actors they connected, new processes and new data, and multiple objects and tools wearables to which are tied.

Table 23.1 provides a synthesis of these elements.

Consistent with Carlile (2002), the researchers' main interest was on how wearables affect practices in the healthcare ecosystem, through an analysis of who actors are, what activities they perform, how they interact with other actors, what resources they use, and how they integrate resources. The aim was to understand connections among actors, the contexts and actions in which these connections arise, the resources used, and the meanings, knowledge, and artefacts through which new practices unfold (Gherardi 2012). By comparing the results of the interviews with observations of the everyday practices and analysis of other sources, the researchers were able to appreciate similarities and differences. Interviewees' own words serve to illustrate themes and their interpretations.

The process of analysing and explaining the phenomena followed a continuously iterative process. Two joint workshops, each lasting 2 h, were organized to include ten chosen informants and experts. During each workshop, the questions centred on the most important issues that emerged in earlier phases, such as those that provoked arguments between patients and their families or a particular healthcare provider or device company. These new concepts accordingly were discussed, evaluated, and further developed.

## 23.7 Findings

New service provision in the healthcare ecosystem emerges through connections in action among data, people, processes, and objects. Two main groups of changes emerge. The first pertains to the way of doing in the social net, which relates to the different ways actors become connected; the second involves the ways data and information are connected and resourceness increases.

### *23.7.1 New Ways of Connecting Actors*

Wearables overcome the separation between healthcare providers and patients and promote connections in action, involving multiple co-creating actors. A connected ecosystem of healthcare providers and other actors emerges, and a specific set of

**Table 23.1** Case studies

| Device (providers) | Features | People | Process | Data | Things |
|---|---|---|---|---|---|
| Adamo (ADAMO) | An assistive watch able to track, monitor, and share data, including both vitals and environmental parameters of the wearer. Designed to assist vulnerable people who live alone | Elderly, pre-set caregiver, service centre | Notify caregivers through the service centre about an emergency | Report to the service centre | Assistive watch, sensors, speakerphone system, service centre docking station |
| Embrace/E4 (EMPATICA) | A smart watch device built for people with epilepsy It is able to detect seizures and alert family and caregivers when necessary | People with epilepsy Research centres, pre-set caregivers | Notify caregivers about an epileptic attack, forward data to research centres | Raw data for researchers | Wristband, Empatica App, Empatica Cloud, Smartphones, Computers |
| Hand Hygiene Compliance T14 (STANLEY HC) | Hand hygiene application that uses real-time locating system technology, disinfectant dispenser attachments, and a dynamic tracking and workflow orchestration engine to automatically and continuously monitor staff members' compliance with defined hygiene protocols | Hospitalised patients, doctors, nurses | Mark activities and issues to be shared with multiple actors | Data diagnosis, treatment plans and consultations | Activity tracker, data analyser, mobile view analytics, wristbands |
| iHealth Kit (APPLE) | Device designed to help manage users' health data. Users can view, add, delete, and otherwise manage all of their health and fitness data. They can also edit the sharing permissions for each data type | Various patients, DOC24 operational centre, ambulance, medical staff | Monitor vital parameters, warn ambulance crews as necessary | Reports to doctors | Health monitors, Vital app, smartphone, Ambulance Data Centre |
| Kardia (AliveCor) | A band that tracks heart rates, then stores and analyses health data using FDA-cleared machine learning algorithms to offer instant electrocardiogram diagnosis | Heart patients, cardiologists, other doctors | Transmit data to cardiologists | Data diagnosis, treatment plans and consultations | Wristband, Alivecor App, Smart watches, Doctor's Dashboard |

| | | | | | |
|---|---|---|---|---|---|
| Kell (KELL) | An integrated health device solution creating a virtual clinical environment. The solutions provide patients with basic information. It also enables virtual clinical consultation with specialists. Patients and family members can get in touch with more than one specialized physician at the same time | People in jail, data centre, hospitals | Monitor health conditions remotely | Reports to doctors | Dynamic Holter, data server, Web tele monitoring platform |
| Pristine (PRISTINE) | An eyesight app created for Google Glass that can stream a video of the patient to the consulting physician. The app allows physicians to see real-time information about patients on the right corner of the Glass and to connect with specialists to provide remote consultations | Patients with skin problems, ER department, physicians and specialists, hospital staff | Connect specialists with physicians in real time | Video and messages | Google Glass, Eyesight app, physician devices |
| Scanadu; Scanaflo Scout (SCANADU) | A device embedded with sensors able to measure vital signs in 30 s: blood pressure, temperature, heart rate, and pulse oximetry. The data are transmitted through Bluetooth to the Scanadu Scout app and recorded on the smartphone | Various patients, general practitioners, specialists | Track data to be shared with practitioners and specialists | Reports to specialists | Sensors, storage disk, Scanadu Scout app, cameras, smartphones |
| Valedo Motion (HOCOMA) | Medical device for back therapy at home. Wearers learn how to do back pain exercises correctly and are motivated to do them regularly | Patients with back pain, doctors | Support people in physiotherapy exercises, share data about movements with specialists | Reports to specialists and personalised exercises | Movement sensors, ValLedoApp, Valedo 3D analyser, physician's device |

activities is performed through which patients, healthcare and service providers, and other actors make sense of their roles in relation to one another and thus collectively co-create value.

#### 23.7.1.1 Engaging Empowered Users/Actors

Through wearables, patients become engaged as empowered users/actors who take active roles in service provision. The new devices change the way users can monitor their vital signs and parameters, especially those related to health risks, in real time and at any location. In traditional health service practices, patients must book appointments to have a consultation and wait some period of time to meet with a doctor. They have no role in medical decision making, due to their lack of knowledge and minimal access to information. But the new connected technologies instead enable patients to monitor, track, and share data about their health, thereby overcoming the physical constraints of time and space.

For example, the AliveCor Kardia wearable provides the ability to track heart performance anywhere, anytime, and at low cost. The app processes data and records them on the user's smartphone, smart watch, or other smart device. In addition, users can record voice notes to detail any palpitations, shortness of breath, or dietary habits that could be linked to heart rate fluctuations. The data then can be sent to the doctor, who can view the electrocardiogram (ECG) results and establish an immediate analysis of the patient's condition. Patients and doctors together can decide how and when to review the ECG.

> *I most like the simplicity. Apart from the connectivity issues the app is very user friendly. The device itself is glorious in design, very sleek and attractive. Living in a world of seizure it is nice to have such an unobtrusive and attractive device. I feel it is easy to take care of my own heart health* (Interview 14, AliveCor user).

Based on similar technology, and developed by Empatica, the E4 Wristband is a bracelet embedded with a sensor that enables patients to track and monitor seizures and physiological data (as in the case of people living with epilepsy), both in real time, through the app, and via USB on the computer. This wearable is suitable for many situations, from laboratory settings to at-home analysis.

> *I'm very, very excited to use E4. I feel protected by it, which in turn sets me free to live my life without limits* (Interview 2, E4 user).

By automatically connecting the data through the cloud, consumers gain a more comprehensive view of their vitals and can easily share information with healthcare professionals or loved ones. Through the Alert system, medical professionals can detect any anomaly in measurements of vital parameters and contact users immediately for further investigation.

> *Through IHealth Kit I can consult a doctor without expectations and without being moved through medical consultation telephone, videoconference, or by email if it is needed* (Interview 6, iHealth user).

These new connected technologies thus are changing the context of healthcare service provision. The focus has shifted, from a doctor-centric to a patient-centric perspective, and the service has moved to a user context, in which users take a more active part in health service provision.

> *People suffering from epilepsy were accustomed to wearing electrodes on their chest and their head to track seizures and other parameters and the tracking was limited to the time during which the patient wore the device. The patient had to wear the detector in a not convenient, nor comfortable, and not stylish way. With E4, doctors can detect seizures every time they happen through the app, instead of just when electrodes are applied on the patient's body. Thus, people wearing the wristband can come back to the hospital also after one or two months; at the same time, the researcher can monitor the data through the app* (Interview 22, Empatica staff).

As a consequence, people are taking their health into their own hands through new smart devices. Actors use devices and collect data on their health and well-being and store information wherever they are (home, office). In turn, patients and doctors can work toward improved health, together.

> *The river of healthcare is moving. People are taking health into their own hands. The centre of gravity of healthcare has moved from hospitals to patients and from clinics to the home. Now health service is mobile* (Interview 9, Adamo staff).

> *We need different models of care with patients being treated at home, and greater use of technology around big data and predictive analytics to find the best care for patients. It is about keeping them out of hospital by keeping them informed* (Interview 15, physician).

#### 23.7.1.2 Widening A2A Interactions

The use of wearables in the healthcare ecosystem has expanded the relationship context, from dyadic interactions of doctors and patients to networked ecosystem relationships involving a variety of individual actors. In traditional health practice, physicians are the only people to whom patients turn. Their professional status has implications for the interaction styles adopted, involving formal, closed relationships that often rely on imbalanced power and standardised procedures. In the new context of wearables though, new and different actors enter the market, such as caregivers, data services, and family members, and offer new resources to be integrated. The Adamo device generates an alarm in case of an emergency, even when the person is unable to activate the alarm (e.g., having fainted, a fall followed by immobility). People can upload emergency numbers through a simple watch; they can upload caregivers' and relatives' details and receive information about their relatives when needed. When an alarm occurs, the system transmits all useful information to operators of the services centre to manage the emergency. The service centre is staffed by social and health professionals who are experienced dealing with emergencies and who evaluate the situation severity and the best way to proceed. The operators also automatically establish direct communication with the wearer, caregivers, or operational staff via the hands-free module present on the base station,

thereby activating a first level of intervention and assistance. In addition, the service centre operates in a personalised manner, based on the data sheet for the person being monitored (habits, state of health, any reported illness), and activates the emergency service only in response to a real need.

> *In modern society there are more and more elderly people, and family members feel the need to have instruments to monitor their health conditions in order to feel secure that, in case of danger, help arrives on time. The caregivers, the wearer, and operational centre staff co-create through the device monitoring the health conditions* (Interview 9, Adamo Staff).

Embrace is a wearable that helps people who suffer from epilepsy. It can also be put on a child's wrist to monitor his or her sleep and notify caregivers or family members about an epileptic attack when something goes wrong, such as shortness of breath or crying. It also can be worn by people during workout routines.

My daughter starts to have a seizure and the wearable sends me a message saying: 'Annie needs your help'—it's amazing. Everybody can have someone, mom/dad/ etc. to be notified. She has had seizures in her room and it was very scary for her because she was alone. This will make it so I can be at home alone or anywhere and if it happens again, I or mom will be notified. (Interview 8, caregiver of Embrace user).

> *I really think it is useful in getting help when I need it from my caregiver (my husband). I really enjoy this and can't wait to see how great it gets as things get fixed!* (Interview 13, Embrace user).

Thanks to the new devices, doctors can connect with caregivers, experts, and/or other specialists from their network and gain confidence in their diagnosis or specific therapy.

> *The Kell system allows to deliver health care at a distance, creating an environment where a virtual clinical environment provides patients with basic information and specialists' clinical consultation. Specialists are able to visit patients virtually, and they can do everything except for things that involve touching the patient* (Interview 16, Kelly staff).

Healthcare has moved from asymmetric to more balanced relationships; it is no longer seen as the responsibility of a single physician. This shift has entailed the abandonment of the single-expert model in favour of a shared, distributive, and collaborative service network, including patients, caregivers, and other actors in an equal co-creation role. For example, E4 enables doctors, hospitals, and researchers to integrate the device into their more complex systems, with other doctors and researchers, as well as other medical sensors and machines for purposes such as eye tracking.

> *Through the E4 wristband, the user is in contact with doctors and researchers who can continuously monitor parameters, leading to more complex information to provide a more complete picture of the user's health conditions* (Interview 4, E4 member).

### 23.7.2 New Ways to Increase Resourceness

New service provision is linked to how data and information connect and knowing emerges, as connections in action. Such connections enable resource accessibility and resourceness. The physicians are not the unique actors that have and transfer knowledge; all the actors participate in knowing processes.

#### 23.7.2.1 Widening Resource Access

New technologies affect how data and information are gathered and used. In traditional health practices, doctors and researchers had to meet patients in their office to study and research parameters linked to episodes of illness. Taking into consideration the events related to illness episodes, physicians could observe only data recorded during the visit, and if something happened when the patient was outside of the health centre, it was impossible to study the symptoms. But wearables enable continuous real-time data acquisition in daily life and facilitate more complete understanding. Patients gain more consciousness and control over their health; physicians get information about daily habits. Such information can be analysed by those who know how to interpret it, potentially catching problems before they start.

> *The Kardia device enables users to self-check, monitor, and continually record data and transmit it to doctors. In this way, the doctors can better understand diagnosis and treatments and also evaluate whether a single episode is related to some other phenomenon, such as the patient recently ingesting caffeine or sleeping poorly, or some other external factor* (Interview 10, physician of Kardia user).

Through wearables, knowledge is co-created through continuous, real-time observations of healthcare parameters, which also advances understanding of human behaviour in real-life settings. Both Embrace, through the Mate app, and the E4 wristband, through the Real-Time app, connect to a user's smartphone or desktop computer via Bluetooth to monitor brainwaves and detect seizures automatically. Doctors thus can detect seizures every time they happen; in addition, they can correlate seizures to symptoms and help identify whether certain factors influence them. Data become richer by including new information about the wearer, so they enable decision makers to obtain a full understanding of their meaning. The Mate app records everyday activities, diet, workouts, and sleep quality, making it possible to define a complete framework of the user's habits and link them to seizure events.

> *New data streams from devices linked to the Internet will demystify health for the public and provide patients with knowledge to live better lives. If a patient is involved in their care, evidence shows they have a better chance of a more successful and quicker outcome, and their demand on services is reduced (Interview 15, physician).*

All of the recorded raw data also can be viewed, organized, assessed, and downloaded on a secure cloud platform so that physicians can have all the parameters they need to conduct research about epilepsy and its connection to other behaviours. Through the device, doctors can link causes to effects—that is, everyday

activities to illness episodes. Kell has set up a mobile clinic with an adjoining telemedicine network that allows exams to be conducted in prison facilities and then shares the data collected with other actors of healthcare ecosystem. Specialists can view and analyse the data, then make them available to doctors in the prison facilities. All patients follow guidelines provided for the treatment.

> *Technology has come to the 'rescue' of physicians and users, helping them to manage information and communicate better to maximise assistance and improve care and well-being (Kell staff).*

Valedo also is equipped with motion sensors that capture even the smallest body movements, in real time, using the latest Bluetooth technology. Users can perform therapeutic exercises, in the form of easy and fun video games, with no mistakes, and progress will be constantly monitored on the patient's device, as well as by physicians, through a direct connection. With this documentation of patients' therapy progress, physicians can optimise therapy planning.

> *When you empower individuals rather than dictating to them, you begin to see that real change. We need to personalise services and be more proactive and introduce immediacy and they will respond* (Interview 7, Valedo staff).

#### 23.7.2.2 Resourcing in Interactions

In traditional practice, doctors' knowledge was based on their medical studies and professional experience, and diagnoses were based on episodic observations of the patient's health conditions. Doctors had to search patient information and medical history in a folder, stored physically and/or electronically, which took substantial time. Even if patients needed consultations with different specialists, they could only meet one physician at a time, then had to book another visit with another doctor. There was no means to exchange information and data, except when doctors asked for patients' health information. The Pristine company, using Google Glass in combination with the Eyesight app and Pristine Checklists, seeks to change the way doctors acquire and share information and data. It enables them to get remote help from experts. The EyeSight app links physicians with specialists, to provide remote consultations. Thus, doctors can conduct coordinated video consultations for patients who require them, using the Glass to transmit useful information, videos, and snapshots. In addition, physicians can access the patient's medical information using a voice command that prompts the information to appear on the Glass. These data are fully secured and encrypted.

> *The Indiana University Health Methodist Hospital became the first hospital in the USA to use the Google Glass to perform surgery to both remove a tumour and reconstruct an abdominal wall. During the intervention, physicians can use voice commands within the Glass to access information and imaging results and view them on the Glass. Moreover, through the Glass, doctors can see the patients' MRI scans and x-rays within their field of view, all hands-free and without moving the eyes from the patient. (Interview 16, Pristine staff)*

The data come from multiple interactions within webs of relationships, based on actors' ability to relate and their potential to act. The Embrace device is pre-set to a specific level, based on the history and health profile of the wearer. The Alert app is automatically activated when an event is detected by the watch sensors, then sends an alert notification through an automated call or message to caregivers, using the mobile device's cellular data or Wi-Fi connection. In the case of a false alarm, the user can adjust the pre-set parameters to be less sensitive. The devices embody various information, acting as context enablers within, shapers of, and bridges between different service and health settings.

> *Patients who suffer from epilepsy usually took notes about everyday activities in a diary. When I have my periodical appointment with a physician, usually every one or two months, he has no time to check my daily diary as the visits are limited to 20/30 minutes every time. The Embrace is impressive! Through the Real-Time app the doctor is able to see everyday data real-time and anytime. He can have a more complete understanding of the gravity of the phenomenon thanks to staying connected and informed on what is happen. (Interview 20, Caregiver of Embrace users)*

## 23.8 Discussion

This study helps move beyond a traditional view of service innovation via service systems focused on new artefacts and new product/service developments with approaches that are more sensitive to social, cultural, and technological issues within the service ecosystem. The focus shifts from individual devices to the sociomaterial practices enabled via application of the IoE in the healthcare ecosystem.

The IoE is a broad term that encompass connections among four dimensions: people, things, data and processes (Cisco 2016). The IoE widens the IoT (one of IoE's four dimensions) by changing how people and things connect, how data are collected and harnessed, and how intelligent processes are developed (Bradley. et al. 2013). The IoE is not about these four dimensions in isolation; each amplifies the capabilities of the others, and it is at the intersection of all the elements that its transformative value emerges (Demirkan et al. 2015). This chapter addresses how the IoE is changing the ways of doing and the actors, activities, and resources of the healthcare ecosystem, in a profoundly new way. In the healthcare ecosystem, new service provision emerges not simply as new artefacts (e.g., wearables) but also as interlinked people, data, objects, and processes. For example:

- Providers develop improved solutions, such as continuous monitoring, tracking, alerts, and sharing of vital parameters and healthcare conditions, leading to new value propositions that can continuously assist users. Patients participate in the service provision as active actors that use wearables, activate their functions, monitor parameters, and collect and share data and information.
- Devices are not simply tools to provide new services but also allow patients to be more active and participate in service provision, as well as enabling the involvement of new actors, beyond the dyadic relationship between patient and doctor.

Multiple actors (patients, doctors, caregivers, parents, hospitals, research centres, health centres) become connected through the new technologies.

- Data become richer by integrating new information about wearers (i.e., health parameters), such that decision makers (e.g., doctors) obtain a fuller understanding of the meaning behind the data collected.
- Processes are becoming more complex and interconnected, affected by changes in that they are now fulfilled by the technology, which acts as an enabler. They have been designed to transfer appropriate data, at the right moment, to the right person, in the best way, leading to better service provision in terms of time and risk reduction.

New service provision in the healthcare ecosystem emerges in its full complexity through the connections in action among data, people, processes, and objects. Two main groups of changes were observed in our study. The first pertains to the way of doing in the social net, which involves the different ways actors become connected and develop networked relationships, thereby overcoming time and space constraints. The second group of changes refers to the ways in which data and information are gathered, such that knowledge emerges and is shared by all the different actors through actions and relations.

We label the first kind of change "networking practices", which are ways of connecting heterogeneous actors and resources. The IoE makes it possible to overcome the separation between healthcare providers and patients and promote connections in action, involving multiple co-creating actors. A connected ecosystem of healthcare providers and other actors emerges, and a specific set of activities is performed, by which patients, care and service providers, and other actors make sense of their roles in relation to one another and collectively co-create value.

The second group of changes are "knowing practices", which emerge through the interconnections or "entanglements" of different forms of knowledge and enable actors to modify the status quo of innovating and promoting changes. Thanks to the IoE, knowledge shifts from the scientific domain of physicians, as processes of managing and transferring information or sets of codified data, to knowing that involves actions and interactions. This implied perspective is shared by multiple actors through their participation in interconnected activities. In the health ecosystem, knowing is co-constructed through interaction between patients (wearers), doctors/researchers, other actors, and devices, through which a common understanding emerges.

The two groups of practices, networking and knowing, are strictly interconnected, allowing a wider framework to emerge (Fig. 23.1). This framework addresses how sociomaterial practices are changing and new connections in action emerging in the healthcare ecosystem, due to the IoE. All actors participate in social and technological interactions to support new service provisions. The reconfigurability of objects moves them from simple, physical products with a static existence into a dynamic service platform (Ng and Wakenshaw 2017), which enables a non-predefined set of actions and resource integration. From this perspective, wearables are digital artefacts that enable the liquification of information resources that enable actors'

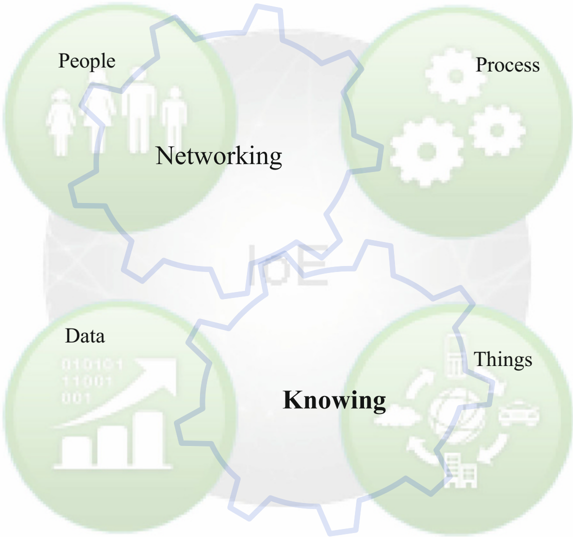


**Fig. 23.1** Innovating in sociomaterial practices

engagement (Ng and Wakenshaw 2017). The activities undertaken by physicians and patients underline the possibility for physicians to use data collected by patients and communities to co-create their diagnosis and cure. Patients become empowered, engaged, and better able to improve their own health, without time and space constraints.

The IoE also enables a democratisation of health, because healthcare moves from hospitals to homes, and from passive patients to knowledgeable actors; every day, people can monitor and understand their health, wherever they are, through a human-centred suite of consumer products that exploit modern science and technology. A variety of actors then can be involved; the focus shifts from the dyadic relationship between doctor and patient to the engagement of research centres, caregivers, family members, and device providers (Joiner and Lusch 2016). New devices are not only a technological improvement but also resources to be integrated within actors' activities and A2A relationships (Joiner and Lusch 2016). They thereby alter the information asymmetry and enable new connections in action (Mele and Russo-Spena 2017; Russo-Spena and Mele 2016), changing what actors do and how they do it.

We regard the IoE as a strong enabler of changing practices that emerge through the connections of knowledgeable actors (doctors, patients, health intermediaries, caregivers). It affects the social side of the community, supporting the evolution of social arrangements and institutional structures. We emphasise the social and technological connections that occur among groups of actors—individuals, collectives, organizations—that integrate multiple resources (e.g., tools, knowledge, images, material objects), as well as the contexts in which knowledge creation and sharing take specific forms for innovation to occur. The practices are connections, sustained by on-going series of relationships in action. The connections in action involve both human and non-human elements, which are interwoven in a texture of

interconnected practices. The texture view offers a framework to address the complexity of the networked connection of complex systems (i.e., service systems and ecosystems) through the creation of different links (M2M, machine-to-people, people-to-machine, people-to-people). In these connections in action, complexity unravels, due to the variety and variability of resources, contexts, people, data, things, and processes.

Changing practices increasingly are infused with social aspects, as well as technologies and other materialities (e.g., places, material artefacts, bodies, infrastructures). Sociomateriality goes deeper than relationships and materiality; it provides room for clear attention to the practices of actors situated in a network of relations and artefacts and the consequences those actions generate. Humans and non-humans together compose complex adaptive service systems that are affecting and being affected by innovating as new sociomaterial practices.

## 23.9 Implications for Managers

This study shows how the IoE facilitates the connection between things but also among people, processes, data, and things. In this view, technology has a social support role that enables connections among a variety of human and non-human actors that co-construct innovating as a texture of practices. Thus, the IoE offers great opportunities for healthcare, as new technologies allow users to go beyond the dyadic (doctor–patient) approach toward a balanced network of actors in the health ecosystem (doctors, patients, health intermediaries, caregivers). In addition, beyond traditional sources of data generated from healthcare and public health activities, managers have the opportunity to diffuse a culture and an organization of health care that is integrated into an ecosystem that includes hospitals, home care, skilled nursing facilities, and other organizations and actors—with more opportunities for communication, relationships, and collaboration between and among those settings.

New stakeholders and new capabilities emerge as technologies, analytical methods, and policies change and adapt in an effort to realise the potential of big data in health. This environment implies that managers must recognise new possibilities and challenges, as well as new risks and difficulties to address. The IoE also implies new roles for professionals and other actors, due to increasing knowledgeability; knowledge is no longer just in the hands of physicians, because all actors become more knowledgeable through new technologies. Managers must overcome a hierarchical mind-set in which physicians dominate and the emphasis is on individual responsibility; rather, they should favour a healthcare approach based on active contributions by patients and other actors who provide added insight and relevant information. Knowing in healthcare practices is a result of activities that are co-created through continuous, real-time observations of healthcare parameters. The opportunities provided by the IoE mean that managers can focus on how to manage resource integration for effective service provision (data collection, analysis and transfer, monitoring and diagnosis, assistance and care) in a new way, leading to

both cost reductions and improved treatments. In the new e-health ecosystem, health professionals and other actors must work together, displaying more coordination and collaboration efforts respect to the traditional interdisciplinary teams. Many factors, including distinct professional and personal perspectives and values, role competition, personal accountability, and unique languages or knowledge standards, could decrease a health ecosystem's ability to function in an integrated way. Such hindrances might cause fragmentation or a partial approach to care, in which technology predominates over patients' needs. All these aspects need to be managed accurately to avoid overlapping or conflicting data or costly and confusing diagnoses that could be deeply detrimental to the patient.

In this view, the IoE implies the need for new corporate competences, especially to be able to handle the vast amounts of data, elaborated by a variety of actors and different devices. In parallel, there is a need to address new problems related to compatibility across the different data and how to elaborate them. Growing concerns about privacy and security also demand new technology strategies and policies that can determine and control how personal data are used and shared. In the healthcare industry, the IoE and new technologies thus create emergent responsibility challenges for all actors involved (hospitals, doctors, users, other health service providers), who must find a new approach to co-create personal healthcare.

## 23.10 Implications for Research

This chapter presents innovating as "a texture of practices" that rely on other practices (Mele and Russo-Spena 2017). This conceptualisation goes beyond an economic view to emphasise the social-contextual nature of innovating, as a complex phenomenon (Gherardi 2012, 2015). The focus shifts to the activities, actors, and resources involved in the sociomaterial practices in which innovating occurs (Russo-Spena and Mele 2016). Practices, as social phenomena, are not fixed or standalone activities; they emerge as connections in action that involve humans and non-humans and that are interwoven in a texture of interconnected practices (Gherardi 2006, 2012; Reckwitz 2002; Schatzki 2002). This perspective on innovating enriches the mainstream view within service sciences. The texture framework also offers insights to grasp the complexity of socio-economic-technical systems (Spohrer 2017). Service scholars could contribute to its further development and application.

As its analysis context, this chapter uses IoE and wearables; further studies might extend this purview to offer more understanding of new digital technologies. Innovation driven by new digital technologies represents the grand challenge in the development of service science. Scholars accordingly have highlighted digitisation as a new layer of connected intelligence (Ng and Wakenshaw 2017), affecting actors, activities, resources, and processes.

The seamless combination of embedded intelligence, ubiquitous connectivity, and deep analytical insights imply knowledge and innovation to be created in action.

The IoE promises to foster innovation in complex service ecosystems that integrate human and technical systems. Therefore, researchers should focus more on the evolving, multi-faceted nature of service ecosystems by addressing how actors can dynamically combine and integrate information, data, actions, tools, and other resources in sociomaterial practices. The emphasis should be on how humans and non-humans combine and configure connected technologies to increase their ability to create better benefits and enhance human well-being.

The integration of technologies continues, shifting to more intelligent devices that combine humans with robotics through powered wearables. An interesting context of analysis involves powered exoskeletons, wearable robotics, or powered clothing, which promise to change people's lives in surprising ways. These new devices can amplify patients' abilities and functional mobility, thus enhancing their everyday lives. As the potential applications of the IoE and wearables continue to grow, further studies should address in greater depth their sociological and cultural impacts. The multiple, pervasive effects of new digital and robotics technologies should be analysed further, in terms of new opportunities and weaknesses, to provide a more complete picture of the business and society as complex service ecosystems, continually mutating in their processes.

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# Chapter 24
# Toward the Service Science of Education

**Oleg V. Pavlov and Frank Hoy**

**Abstract** This article applies the service science framework to higher education. To understand the reasons behind the success and failure of academic programs, we build on the previous literature that suggests that education is a service delivered by universities, which are viewed as complex systems. We contribute to the service science theory by introducing a methodological tool called the Service Science Canvas, which incorporates elements and principles common to all service systems. The Service Science Canvas is a convenient tool for identifying components of academic programs. This article reviews educational programs in entrepreneurship, and, as a case study, it examines an entrepreneurship program at a technological university in the United States.

**Keywords** Higher education · Academic program management · Service systems · Service science · Service Science Canvas

## 24.1 Introduction

Increased market competitiveness and globalization requires universities to be entrepreneurial and innovative in all their activities (Christensen and Eyring 2011). For example, in their efforts to reduce cost and recruit non-traditional students, universities have been experimenting with online and competency-based education. In order to teach students skills that would allow them to be innovative and able to

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We thank the Coleman Foundation for its support of the Faculty Entrepreneurship Fellows program at Worcester Polytechnic Institute. This project started as a discussion among Coleman Fellows on the relationship between innovation and entrepreneurship education. Early versions of this article were presented at the INFORMS Annual Meeting, Philadelphia, PA, November 4, 2015, and EDULEARN17: 9th International Conference on Education and New Learning Technologies, Barcelona, Spain. July 3–5, 2017.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_24

work in teams on unstructured tasks, universities have been introducing entrepreneurship concepts even in non-management courses (Murphy et al. 2011; Barile et al. 2012; Fetters et al. 2010; Welsh 2014; Graham 2014). In the near future, as automation reduces job security (Brynjolfsson and McAfee 2014) and employment shifts toward the "gig economy" model (Mulcahy 2017), basic knowledge of entrepreneurship will become even more relevant.

Despite the strong interest in entrepreneurship education, bringing entrepreneurship to campus has proven to be challenging (Nelson and Lumsdaine 2008; Roberts et al. 2014; Morris et al. 2014). Difficulties include resistance from administrators, faculty, alumni and staff (Fetters et al. 2010; Morris et al. 2014). Entrepreneurial aspirations of universities may be viewed as interfering with their traditional academic mission (Kaplin and Lee 2007; Lucas 2006). It is commonly feared that commercialization of research may interfere with the free flow of information and will suppress academic scholarship (Fetters et al. 2010). Lack of institutional support, inadequate resources and poor coordination among quixotic enthusiasts can doom any campus initiative (Fetters et al. 2010; Morris et al. 2014). On the other hand, thriving entrepreneurship programs are typically part of vibrant local innovation ecosystems with ready access to resources and networks of professionals who offer support and advice to budding entrepreneurs (Fetters et al. 2010; Graham 2014).

To diagnose and avoid many pitfalls and setbacks associated with establishing and managing an academic program, entrepreneurship education research needs a holistic and unifying theory (Winkler 2014). This article suggests that service science (Spohrer et al. 2007), which aims to understand service production, is uniquely suitable for the analysis of education. Service science takes a comprehensive view that emphasizes co-creation of value by all stakeholders with the recognition that maintaining service growth and service excellence in the long term is hard. We build on earlier literature that proposed that service science could help understand evolution of higher education (Spohrer et al. 2007, 2013; Lella et al. 2012). According to service science, education is a service delivered by universities, which are complex systems.

According to service science, all service systems share 10 common elements and principles (Spohrer et al. 2007). As a methodological aid, we introduce the Service Science Canvas, which groups these elements and principles into a 10-block matrix. The Service Science Canvas is a tool for service science analysis, not unlike the Business Model Canvas (Osterwalder and Pigneur 2010), which is a compendium of a business plan. Due to its convenience, the entrepreneurship community have embraced the Business Model Canvas as a planning and visualization tool (see strategyzer.com for examples). The Service Science Canvas is a generic service science template that can be used to describe any service system. This article applies the Service Science Canvas to education.

The next section describes our methodological innovation, the Service Science Canvas. Then we demonstrate how to adapt it for a generic entrepreneurship program. Using this modified canvas, we analyze the cross-campus entrepreneurship education at Worcester Polytechnic Institute (WPI), which serves as a case study.

We conclude in the last section by discussing limitations of this article and suggest future extensions for this line of research.

## 24.2 The Service Science Canvas

In service science, dynamic networks of resources that produce and deliver value to stakeholders are called service systems (Spohrer et al. 2007). Examples are numerous and include business units, firms, towns, government agencies, and countries. Being a universal concept, examples include firms, business units, cities, government agencies, and nations. Even academic libraries (Lyons and Tracy 2013) and the Bay Area Rapid Transit (BART) system in San Francisco (Glushko 2013) can be viewed as service systems.

The common thread between diverse applications are the ten general elements and principles that are applicable to all service systems (Spohrer et al. 2007). The Service Science Canvas in Fig. 24.1 assembles these elements and principles into a 10-block matrix, as we explain in this section.

Each block contains text that describes the corresponding element or principle. A researcher may use the Service Science Canvas as a guide for parsing and

**The Service Science Canvas**

<table>
<tr>
<td rowspan="2">RESOURCES<br><br>What resources are part of the service system?<br>Which resources are physical and which ones are not?<br><br>Resources can be physical (e.g., technology), non-physical (e.g., intellectual, financial), with-rights (e.g., human), or no-rights (e.g., bits).</td>
<td rowspan="2">ACCESS RIGHTS<br><br>Are the resources shared, owned, leased or privileged?</td>
<td rowspan="2">ENTITIES<br><br>What are the entities that are part of the service system?<br>Entities are dynamic.<br><br>Entities can be formal or informal.</td>
<td>STAKEHOLDERS<br><br>Who is affected by the service system?<br><br>The fundamental stakeholders are customers, service providers, authority and competitors.</td>
<td>VALUE CO-CREATION<br><br>How does each stakeholder contribute to the value co-creation? What value propositions do they offer others and seek agreement on?</td>
</tr>
<tr>
<td>NETWORKS<br><br>What are the patterns of interactions between service systems and between entities? How are they nested?</td>
<td>ECOLOGY<br><br>Are there multiple interacting service systems and entities ?</td>
</tr>
</table>

<table>
<tr>
<td>GOVERNANCE<br><br>How are activities coordinated?<br><br>How are contracts enforced?<br><br>How are disputes resolved?</td>
<td>OUTCOMES<br><br>What are the outcomes of the activities by the service system?<br>Examples of outcomes include value created, contracts agreed on, disputes resolved, or unresolved.</td>
<td>MEASURES<br><br>What are the appropriate tangible measures of quality, productivity, compliance and sustainable innovation?</td>
</tr>
</table>

**Fig. 24.1** The Service Science Canvas groups together the ten elements and principles of the service science

documenting a service system. It ensures that no element or principle is overlooked and that each element is properly recorded.

### 24.2.1 Resources

Consistent with the resources-based view in the management literature (e.g. Pavlov and Saeed 2004), anything that can be used in service production is a resource. Examples include people, technology, information, and organizations (Spohrer et al. 2007; Chen et al. 2008, p. 122). Financial resources can be converted into real resources—a building can be leased and additional staff can be hired.

### 24.2.2 Access Rights

Access rights control resource availability and use (Spohrer et al. 2008; Barile and Polese 2010). Service science differentiates between several fundamental access rights: owned, shared, leased and privileged (Spohrer and Kwan 2009). We can own outright private property. An example of a leased resource is a rental car. Common resources such as air and roads are governed by shared access rights. Knowledge has privileged access rights. While describing a library as a service system, Lyons and Tracy (2013) suggest the fifth category of access rights—open access.

### 24.2.3 Entities

Resource can be combined into configurations called entities, which are capable of value creation (Spohrer et al. 2008; Spohrer and Kwan 2009). Entities can be formal or informal, they can emerge and disappear over time (Maglio et al. 2009).

### 24.2.4 Stakeholders

Parties affected by service production and delivery are called stakeholders (Spohrer et al. 2008). Based on their roles, service science specifies four fundamental stakeholder types: customers, providers, authority and competitors. Customers receive the service. Service systems receive resources from providers. Providers also produce the service. Rules and laws are enforced by authorities. Competitors are alternative producers of services; they drive innovation.

### 24.2.5 Value Co-creation

In successful service systems, value is created through collective activities of stakeholders (Chen et al. 2008), which builds up confidence and trust in the service system. The value co-creation principle sustains service excellence in the long term by giving a sense of direction to all activities, which is crucial for the extended successful operation.

### 24.2.6 Networks

Networks refer to patterns of interactions between service systems, entities and stakeholders (Spohrer et al. 2008; Barile and Polese 2010; Lyons and Tracy 2013). Among examples of interactions over networks are communications between the authority entity and other entities and the exchange of skills and knowledge between stakeholders. Networks may include nested entities, such as divisions and departments in organizations, and counties and cities in states.

### 24.2.7 Ecology

A service ecology is a network of service systems and service entities (Spohrer et al. 2008; Spohrer and Kwan 2009; Lyons and Tracy 2013). Ecologies vary in size, access rights, network patterns, governing arrangements and the types of service systems and entities that they include. A service ecology may consist of the intermixed populations of diverse types of service system entities interacting in complex networks, including some entities nested within others as well as entities that fill roles in multiple service systems simultaneously (see, for example, Fig. 24.2 in Spohrer et al. 2012).

### 24.2.8 Governance

Governance mechanisms, that range from informal social norms to formal contracts, laws, and regulations, direct service systems towards certain objectives (Spohrer et al. 2008). Rules and laws reduce ambiguity and ensure efficiency of service systems as well as their viability (Spohrer et al. 2008; Barile and Polese 2010; Lyons and Tracy 2013). Governing is carried out by authority stakeholders who measure performance and communicate directives to providers.

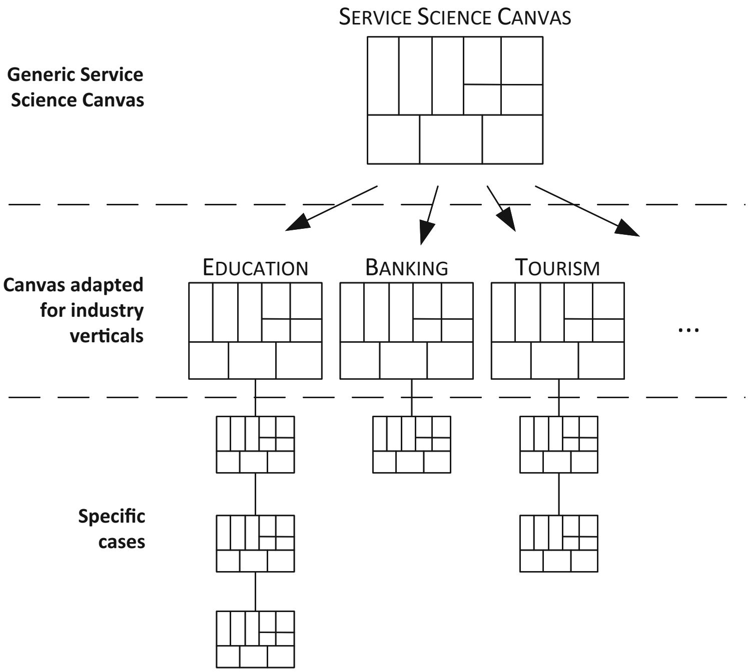


**Fig. 24.2** The Service Science Canvas can be adapted for an industry vertical and applied to specific cases

### *24.2.9 Outcomes*

Among the many outcomes of service systems, the main is the value produced for customers (Spohrer et al. 2008; Maglio et al. 2009). While this is the intended and desired outcome, systems also generate unintended outcomes such as pollution or property disputes. Depending on the industry and particular cases, additional outcomes may include contracts between organizations, earned revenue, depleted fish populations, a culture change within a university and so on.

### *24.2.10 Measures*

Stakeholders evaluate the performance of service systems against benchmarks that are important to them. To do so, they rely on measures of hard and soft variables. A number of widgets produced or a number of students who graduated with a certain major would be examples of easily quantifiable outcomes. Satisfaction surveys and other proxies could be used to capture values of soft variables. Service science

identifies four important measures: productivity, compliance, quality and the level of innovation (Spohrer et al. 2008).

The Service Science Canvas is a generic methodological tool that can be applied to a variety of situations in different service industry verticals. Figure 24.2 identifies three industry examples: education, banking, and tourism. The Service Science Canvases can also be used to analyze specific cases within each vertical. In the following section, we will demonstrate how the Service Science Canvas can be used to identify common elements of entrepreneurship programs. We will then review a specific case of an academic program at Worcester Polytechnic Institute.

## 24.3 Entrepreneurship Education

Ever since 1947 when the first entrepreneurship course was taught in the United States (Katz 2003), popularity of entrepreneurship education has been growing exponentially. In 1967, fewer than a dozen 4-year institutions taught entrepreneurship (Vesper 1983). However, by 2008, more than 5000 courses were taught; and by 2013, about 9000 courses were offered with 400,000 total enrollments (Torrance et al. 2013). Now, entrepreneurship education is offered worldwide (Rice et al. 2014; Graham 2014).

In this section, we adapt the generic Service Science Canvas for entrepreneurship education by conceptualizing an academic program as a service system. This approach follows the sequence suggested in Fig. 24.2. We start with the generic Service Science Canvas as in Fig. 24.1 and modify it with elements specific to education, which results in a modified Service Science Canvas (Fig. 24.3). The modified Service Science Canvas will then serve as a guide and a documentation tool for a case study.

### *24.3.1 Resources*

An academic program cannot succeed without adequate resources (Massy 2016; Pavlov et al. 2014; Zaini et al. 2016). It needs competent faculty and support staff, physical buildings, online resources, and funding. Faculty and staff can work full-time for the program or they can be affiliated with it part-time. Because resource shortages can be eliminated by purchasing additional resources or hiring new staff, the continuity and significance of funding directly contribute to the long-term success of an academic program (Fetters et al. 2010). Not surprisingly, Finkle et al. (2013) found that enduring entrepreneurship programs actively and continuously raise funds from many sources.

Entrepreneurship education has been financially backed by foundations and nonprofits (McMurtrie 2015). Examples include Ashoka, the Moxie Foundation, VentureWell, and the Blackstone Charitable Foundation. The Ewing Marion

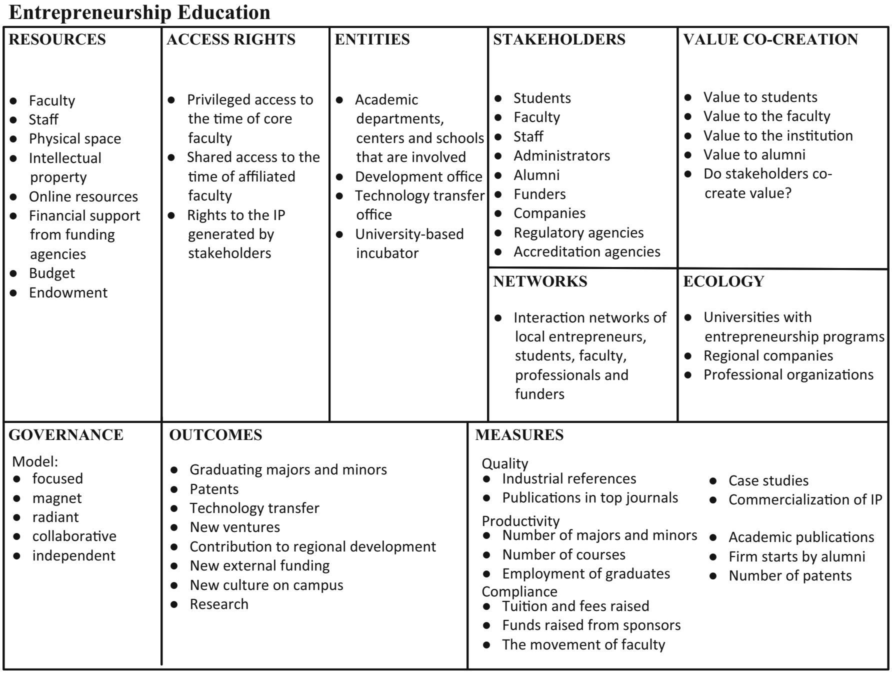


**Fig. 24.3** The Service Science Canvas adapted for entrepreneurship education

Kauffman Foundation was an early supporter of campus-wide co-curricular activities such as entrepreneurship clubs, lectures, and entrepreneurship competitions (Katz et al. 2014). In 2009, The Coleman Foundation launched a highly successful Coleman Fellows Program with the goal of recruiting non-business faculty to teach concepts of entrepreneurship in their courses (Katz et al. 2014).

Universities regularly reach out for support to alumni and benefactors, recognizing the most generous contributors by name. Examples include the Arthurs M. Blank Center for Entrepreneurship at Babson College; the Johnson Center for Entrepreneurship & Innovation at Indiana University; and the Reigner Institute for Entrepreneurship and Innovation at the University of Missouri—Kansas City.

Without the financial support from the home institution, however, many entrepreneurship programs downsize or collapse once external funding ends (Fetters et al. 2010). The longevity of an academic program can be ensured through dedicated endowments and budgetary commitments by the university. A positive side effect of a budgetary commitment is that it strengthens the legitimacy of academic programs in the eyes of stakeholders, which can protect it from the internal university resistance.

### 24.3.2 Access Rights

An academic program would typically share resources such as buildings and equipment with other academic programs at the same university, which leads to a certain degree of competition between programs. While the Bayh–Dole Act of 1980 permitted US universities to own their intellectual property (IP) and allowed them to license and sell it (Kaplin and Lee 2007), entrepreneurship programs individually have no legal claim to the IP even if they are instrumental to the innovation and monetization of the IP. As the only recourse, an entrepreneurship program may negotiate with the home university its share from licensure or sale of the IP. Entrepreneurship faculty, on the other, hand may hold patents to their IP.

### 24.3.3 Entities

Academic entities include universities, programs, departments, centers and schools. While entrepreneurship education started in business schools (Katz et al. 2014; Morris et al. 2014), now it often extends across campuses (Kyrö and Carrier 2005; Morris et al. 2013; Roberts et al. 2014; Welsh 2014). Making entrepreneurship instruction available to the entire campus recognizes that an entrepreneurship program can benefit many academic departments (Roberts et al. 2014; Welsh 2014). Several additional entities are crucial for entrepreneurship programs. Development offices work hard at raising funds, while technology transfer offices and campus-based incubators commercialize inventions. Commercialization can take the form of commercial partnerships, joint ventures, and subsidiary corporations (Kaplin and Lee 2007).

### 24.3.4 Stakeholders

The innovation ecosystem consists of employers, faculty, students, alumni, administrators, local entrepreneurs, non-profit foundations, private funders and investors, as well as professionals such as accountants and lawyers (Fetters et al. 2010, p. 182; Rice et al. 2014). A critical mass of multiple stakeholders on campus ensures program sustainability (Fetters et al. 2010). Otherwise, a change in leadership or a departure of a key faculty member can jeopardize an entire academic program (Katz et al. 2014).

According to service science, any academic program has the following four fundamental stakeholders:

- *Customers*: Students are the main customers (Lella et al. 2012). They derive value from interactions with the faculty, staff as well as interactions among themselves. Additional customers are government agencies and businesses, which recruit

students and cooperate with universities on research and consulting (Lella et al. 2012).

- *Providers*: Educational services are delivered by faculty and staff. Their support and enthusiasm are the main ingredients of any successful campus-wide initiative. An entrepreneurship program typically has a group of core faculty who assist other instructors in introducing entrepreneurship elements in courses (Neck et al. 2014).
- *Authority*: Trustees and administrators set the rules, which govern the university. After reviewing many existing programs, Fetters et al. (2010) conclude that any successful entrepreneurship program enjoys the support of senior university leadership such as the president or dean. Senior administrators pursue funding and act as advocates for entrepreneurship within and outside the university (Fetters et al. 2010). Faculty committees usually control some aspects of academic programs such as academic reviews of new courses and recommendations for academic promotions. National and state organizations enforce laws of higher education (Kaplin and Lee 2007).
- *Competitors*: Academic programs compete for faculty, students and funding, and therefore other educational programs can be viewed as competitors.

In real organizations, stakeholders typically transcend more than one role (Lella et al. 2012). For example, students can become providers, when they take part-time jobs with the university at which they study. Competing universities become educational partners when they join resources in a consortium.

### 24.3.5 Value Co-creation

One of the fundamental ideas of service science is that service production and delivery must be beneficial in some way for all participants. Students value entrepreneurship education because they learn how to scope opportunities, start and run companies, acquire skills for innovation, network with entrepreneurs, and receive access to venture funding. Faculty may appreciate additional opportunities for teaching, research, and co-curricular activities that entrepreneurship programs offer. Trustees and administrators may like extra publicity and opportunities to reach out to alumni and the community for donations (Finkle et al. 2013). Neighboring community may enjoy educational seminars and workshops on entrepreneurship (Finkle et al. 2013). Areas surrounding universities also benefit economically from entrepreneurship activities on campuses (Lella et al. 2012).

Additional value is generated by university-based incubators, which provide opportunities for students to start companies under the guidance of seasoned entrepreneurs. Campus incubators allow faculty supplement research with entrepreneurship activities and investors gain privileged access to the latest research. A university adds value when it arranges for a shared workspace for campus startups.

### 24.3.6 Networks

Universities act as focal points for connecting multiple stakeholders in local innovation networks (Fetters et al. 2010; Graham 2014; Bliemel et al. 2014), which increases success rates for new ventures based on university IP (Holly 2012). Such networks, often supported by charitable foundations, act as conduits for information sharing and catalysts for collaboration. For example, The Coleman Foundation Fellows Program and as The United States Association for Small Business and Entrepreneurship (USASBE) encourage collaboration between likeminded faculty on campuses across the U.S. (Katz et al. 2014).

### 24.3.7 Ecology

While the first class was taught in the U.S., now entrepreneurship education is available worldwide (Graham 2014; Rice et al. 2014). Offerings range from lonely courses to comprehensive university-based entrepreneurship ecosystems, which comprise the global innovation ecology. The global ecology provides opportunities for local experimentation as well as sharing and learning best practices among universities. Two recent comprehensive studies of leading entrepreneurship programs at universities in the U.S., Europe, Latin America and Asia (Rice et al. 2014; Graham 2014) revealed that, while successful programs share many common attributes, local conditions lead to differences in governing structures, participating entities, funding options and the selection of measures that track progress. These studies agree that successful entrepreneurship programs: (1) enjoy strong support by university leadership at the senior and entity levels; (2) must be connected to global entrepreneurship, investment and academic networks; (3) have robust governing infrastructures; and (4) require committed financial resources.

Due to local differences, however, practices that work in one region may not be easily transferrable elsewhere. As a case in point, the Russian government tasked its state-owned universities to develop innovation and entrepreneurship programs on par with leading programs abroad (Graham 2014; Shabad 2016). Unfortunately, these entrepreneurial aspirations have been hindered by the country's centralized governance structure of higher education, state control of university budgets, and the market that is dominated by large state-owned enterprises with risk-averse corporate cultures.

### 24.3.8 Governance

Entrepreneurship programs have followed several governance architectures (Katz et al. 2014; Morris et al. 2014). If entrepreneurship is taught only to business school

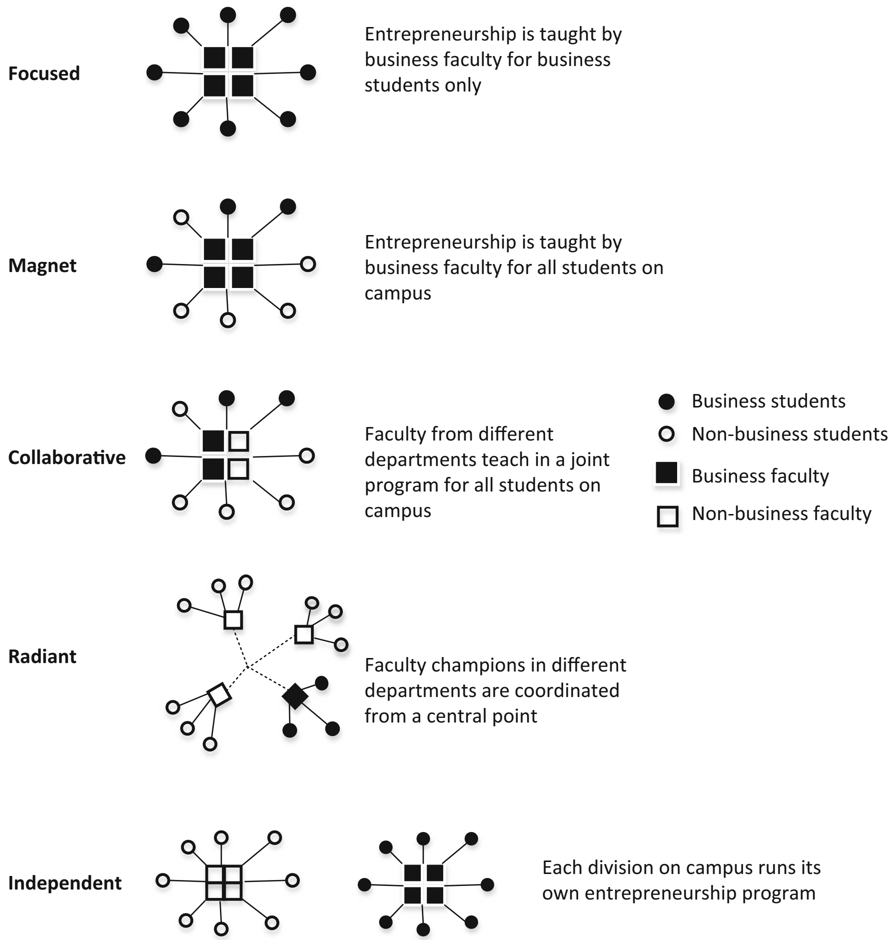


**Fig. 24.4** Governance models followed by entrepreneurship programs

students, this is referred to as a *focused model* (Fig. 24.4). When entrepreneurship courses are open to all majors, yet they are taught in the business school, it is a *magnet system*. In the *radiant model*, faculty champions in different departments on campus are supported and coordinated from a central point. If faculty from different departments work together on a joint program, it is a *collaborative model.* In the *independent model*, divisions on campus run their own programs.

The most common are magnet and radiant governance structures (Katz et al. 2014). Independent programs lead to duplication of effort and may even confuse students because each division may interpret entrepreneurship differently. Additionally, independent centers may lack coordination, and may muddle disjoint fundraising efforts (Morris et al. 2014).

### 24.3.9 Outcomes

The most notable outcomes of an academic program are the graduates and course registrations. Outcomes specific for entrepreneurship programs are patents, technology transfer, and the new ventures launched. Less obvious yet as important are the contribution to the regional economic development, the adoption of an innovation culture on campus, and opportunities to raise additional funds for the university.

### 24.3.10 Measures

Appropriate measures are crucial for tracking its progress and advocating for an academic program. Yet measuring effectiveness of entrepreneurship education poses particular challenges (Roberts et al. 2014). For example, are we justified to assume that there is a causal connection between an entrepreneurship course taken in college and a startup launched by the former student years after graduation (Gulbranson and Audretsch 2008)? It is also hard to quantify such intangible benefits as receiving a quick feedback from a seasoned entrepreneur that convinces a student that a particular business idea is not commercially viable, so the student can move on to the next idea (Gulbranson and Audretsch 2008). In Table 24.1, we compiled measurable indicators for an entrepreneurship program based on the literature and our own personal experiences.

## 24.4 Case Study

This section reviews an educational program at Worcester Polytechnic Institute. We use the modified Service Science Canvas developed in the preceding section as a tool for information collection and organization. While our analysis includes only publicly available information, a more detailed review is feasible with the help of the institutional research division on campus. Despite being relatively brief, this section still demonstrates the practical usefulness of service science and the Service Science Canvas for program review.

### 24.4.1 Worcester Polytechnic Institute

Worcester Polytechnic Institute (WPI) is a technological university in Central Massachusetts. Second only to Boston, Worcester was a major manufacturing center in the nineteenth century. The City of Worcester is now known for its 12 universities, a biomedical research center and several large hospitals. WPI was established in 1865

**Table 24.1** A compilation of possible measures for an academic program in entrepreneurship, based on Gulbranson and Audretsch (2008), Roberts et al. (2014) and our personal observations

| |
|---|
| **Quality**<br>• Industrial references<br>• Publications in top tier academic journals<br>• Case studies that can show clear linkages among industrial products, firms, and university research<br>• Students, faculty and staff involvement in voluntary entrepreneurship activities<br>• Commercialization of intellectual property |
| **Productivity**<br>• Number of entrepreneurship majors and minors<br>• Number of core and affiliated faculty<br>• Number of courses with entrepreneurship components<br>• Longevity of the program<br>• Number of graduates<br>• Employment of graduates<br>• Academic publications<br>• Conference participation<br>• Firm starts by alumni<br>• Number of patents |
| **Financials**<br>• Tuition raised through entrepreneurship related courses<br>• Fees raised through entrepreneurship related workshops and seminars<br>• Funds raised from sponsors for entrepreneurship education activities<br>• The free movement of faculty in and out of the university |
| **Sustainable Innovation**<br>• Continuing involvement of entrepreneurial alumni<br>• Jointly funded research activities between the university and industry<br>• Contract research performed by the university for industry<br>• Informal contacts between university faculty and industrial firms<br>• Specific university-industry training collaborations<br>• Temporary exchanges of faculty with industry<br>• Industry usage of university scientific facilities<br>• New industrial processes, techniques, and instrumentation that can be traced to university research |

as one of the first technological universities in the United States with the purpose of educating the engineering workforce for American factories, many of them in Worcester. This medium-sized university currently offers about 50 degree programs at both undergraduate and graduate levels. In 2016, it had 3800 undergraduate students, most of them engineering and science majors, and about 1700 graduate and professional students. Every year, the university graduates about 40 Ph.D. and 700 Master's students.

We describe entrepreneurship education at WPI by filling out the Service Science Canvas, as shown in Fig. 24.5. Each cell is filled with data for WPI.

**Entrepreneurship Education at WPI**

**RESOURCES**

- Professorship chair
- Professor of practice
- Two junior faculty
- Entr.-in-Residence
- Adjunct faculty
- Coleman Fac. Fellows
- External funding
- Budget allocation

**ACCESS RIGHTS**

- Patenting IP
- IP database
- Inventor's notebook
- Access to full-time and affiliated faculty
- Dedicated staff

**ENTITIES**

- School of Business
- WPI departments
- Office of Intellectual Property and Innovation
- Tech Red Advisor Team
- IP committee
- Tech Advisors Network
- Development Office
- Tech Entr. Club

**STAKEHOLDERS**

- Students
- Faculty
- Administrators
- Staff
- Alumni
- Funders
- Companies
- Regulatory agencies
- Accreditation agencies

**VALUE CO-CREATION**

- IP commercialization
- Value to students: edu programs, access to entrepreneurs and professionals, competitions
- Faculty: opportunities for new teaching and research, 50% of IP value
- WPI: new edu programs, 50% of IP value, external funding
- Alumni: involvement, investment opportunities

**NETWORKS**

- Coleman Fellows Network
- Kern network
- Tech Advisors Network
- National Association of Inventors
- Association of University Technology Managers
- Competitions, workshops, events

**ECOLOGY**

- Student startup projects
- Local incubators
- MassChallenge
- Entrepreneurs student club

**GOVERNANCE**

Model:

- Started as magnet
- Currently, radiant

**OUTCOMES**

- New innovation culture on campus
- Entrepreneurship minor and certificate
- Patents
- Licensing of IP
- Faculty and student startups
- External funding
- Research that leads to commercialization

**MEASURES**

- 47 inventions
- 82 patents filed
- 8 patents issued
- 8 licenses
- 12 startups licensed inventions
- 6 Coleman Speakers
- 200 registrations for 7 non-business courses with entrepreneurship elements

**Fig. 24.5** The Service Science Canvas for entrepreneurship education at WPI

## *24.4.2 Resources*

The university followed the magnet governance model initially when in 1995 WPI launched The Entrepreneurs Collaborative within the Department of Management (Tryggvason et al. 2010). The first courses were taught by faculty and staff who were affiliated with the program part-time. Alumni donations began flowing the same year. In 1997, an alumnus who had co-founded the Collaborative made a major gift of $1 million. The Collaborative changed its name to the Collaborative for Entrepreneurship & Innovation (CEI) in 1999. Endowments from alumni led to the creation of two full-time teaching positions—a Professor in Innovation and Entrepreneurship and a Professor of Practice. Currently, the School of Business, which is the successor to the Department of Management, also hosts an Entrepreneur-in-Residence. The School of Business currently employs four full-time and additional adjunct faculty in entrepreneurship.

The program has been funded by several private foundations, including the Coleman Foundation, the National Collegiate Inventors and Innovators Alliance (NCIIA, which was later renamed VentureWell), the Kauffman Foundation, the

Lemelson Foundation, the John E. and Jeanne T. Hughes Foundation, the Kern Family Foundation, and the Dearborn Foundation. The Coleman Foundation provided many grants starting in 2002; the first grant supported the CEO-East Collegiate Entrepreneurship Conference. Scholarships from the Dearborn Foundation were designed to stimulate undergraduate interest in entrepreneurship. Coleman and Kern Family foundations supported Entrepreneurship Faculty Fellows in non-management disciplines. Annual Invention to Venture 1-day workshops are funded by NCIIA, Lemelson, and the Kauffman Foundation.

Besides private foundations, in 2016, several WPI teams won funding from the Innovation Corps (I-Corps) program by the National Science Foundation (OIPI 2016), with the objective of expanding the influence of the basic research projects beyond the laboratory.

As of now, the university budget includes the entrepreneurship program. The budget accounts for faculty recruitment, conference travel, administrative operations, courses, workshops, networking events, student assistantships, dinners, competitions, and a speaker series.

### *24.4.3 Access Rights*

WPI works with faculty and students on patenting and commercialization of their IP, if it was developed with university resources. All IP on campus is entered into a searchable database (OIPI 2016). Workshops on campus introduce students to the Inventor's Notebook, which is a legal record of research progress. Regular lectures by invited speakers introduce students and researchers to the basics of the patent and business law. The program has access to dedicated core faculty as well as affiliated faculty. Several staff members support the program full-time.

### *24.4.4 Entities*

Entrepreneurship program started in the Department of Management, succeeded by the School of Business. Recently, continuing support from the Kern Family Foundation and the Coleman Foundation encouraged the extension of entrepreneurship to more schools and departments.

Additional entities that are involved in entrepreneurship activities are:

- The Office of Intellectual Property and Innovation (OIPI) works with faculty and students on protecting their IP and commercializing new products and technologies. The office works closely with several advisory groups: the Tech Red Advisor team, the university's Intellectual Property Committee, and the Tech Advisors Network (TAN), which advises WPI on patenting activities (OIPI 2016).
- The university development office, which works with alumni and foundations.

- The Tech Entrepreneurship Club was organized by students to foster the entrepreneurial environment on campus, and it is open to all majors.

### 24.4.5 Stakeholders

The stakeholders block in Fig. 24.5 includes many participants, and still the list is far from complete. Here are additional details on three of them:

*Students*: Minors in entrepreneurship and social entrepreneurship are open to all undergraduate students. Additionally, even non-business students are exposed to elements of entrepreneurship curriculum, which is integrated within many courses on campus. For example, after receiving a grant from the National Science Foundation, WPI initiated a doctoral program in biofabrication, which includes four courses that focus on commercialization of new technologies.

*Faculty*: Full-time and adjunct faculty teach entrepreneurship at the undergraduate, masters and doctoral levels. A cadre of Coleman Faculty Fellows present entrepreneurship concepts to non-business majors.

*Administrators*: The administration has committed to extending entrepreneurship curriculum. In 2014, the provost's office launched a campus-wide initiative on innovation and entrepreneurship.

### 24.4.6 Value Co-creation

WPI encourages research commercialization by following a formal IP process, which stipulates an equal division of revenue between the inventor and the university (OIPI 2016). Based on recommendations from 40 volunteers who review provisionary patents, not all inventions are patented. The corresponding block in Fig. 24.5 outlines additional benefits to stakeholders, yet again, the list is far from complete.

### 24.4.7 Networks

There are ample opportunities on campus to network with like-minded faculty and the local startup community.

- The Coleman Foundation and the Kern Family Foundation sponsor two overlapping networks of faculty interested in entrepreneurship.
- The Tech Advisors Network (TAN) consists of volunteers, predominantly successful WPI alumni, who choose to mentor entrepreneurial teams on campus.
- WPI is a member of the National Association of Inventors and the Association of University Technology Managers (OIPI 2016), the Smaller Business Association

**Table 24.2** Business competitions at WPI

| |
|---|
| Elevator Pitch |
| The Robert H. Grant Invention Awards |
| The I3, Investing in Ideas with Impact |
| The Henry Strage Innovation Awards |
| The Kalenian Innovation and Entrepreneurship Award |
| Earth Week—3R Video Competition—Reduce, Reuse, Recycle |
| The Hitchcock Innovation Prize |

of New England, the Worcester Business Resource Alliance, and the New England Chapter of the Family Firm Institute.

- Campus (Table 24.2) and off-campus business competitions provide opportunities to network. Some faculty encourage student participation in competitions by making it a requirement in their courses. Additionally, WPI organizes entrepreneurship workshops, speaker events, and dinners with entrepreneurs.

### 24.4.8 Ecology

WPI is actively involved in the local innovation ecosystem. Student teams have performed feasibility studies, product design and testing, and commercialization plans for startups. WPI ventures may join several local incubators: the Massachusetts Biomedical Initiative, Running Start, Technocopia, and the Worcester Clean Tech Incubator. Joint student-faculty teams from WPI have also participated in MassChallenge, which is a Boston-based startup competition and accelerator.

### 24.4.9 Governance

Driven by the interest in entrepreneurship on campus as well as by the continuous outside financial support from several foundations, the program has evolved from the original magnet model housed in the Department of Management to the radiant architecture with affiliated faculty across the campus.

### 24.4.10 Outcomes

Figure 24.5 touches on some of the outcomes of the program. Among the most challenging and profound outcomes of the WPI entrepreneurship program is the shift toward innovation on campus, which is a significant cultural shift for the university. The program provides role models through such events as the Coleman Entrepreneurship Speaker Series. Faculty attend workshops and conferences aimed at

enhancing their skills in teaching entrepreneurship. Two popular destinations have been The Experiential Classroom at the University of Florida and the Collegiate Entrepreneurs' Organization (CEO) Conference. Students are provided with educational opportunities, including a minor in entrepreneurship or social entrepreneurship and a graduate certificate in entrepreneurship.

### *24.4.11 Measures*

In 2016, 47 inventions were recorded, 82 patents were filed and eight patents were issued (OIPI 2016). Since 2012, 12 companies licensed inventions from WPI, including eight in 2016 (OIPI 2016). Among many seminars on campus, the Coleman Entrepreneurship Speaker Series organized six lecturers in the 2015–2016 academic year. During the same academic year, 200 students registered for seven courses with entrepreneurship elements, which were taught by non-business faculty.

## 24.5 Conclusion

This article builds on earlier literature (Spohrer et al. 2007, 2013; Lella et al. 2012) that proposed using service science to study education provision. Service science is a theory of building and sustaining efficient service systems, including universities and academic programs, with special attention paid to value co-creation by stakeholders, the need for sufficient resources and the importance of measuring progress. As a methodological tool, we introduce the Service Science Canvas, which is a generic template suitable for a variety of service industries. To demonstrate the use of the Service Science Canvas, we review programs in entrepreneurship. Based on the extensive case literature, we identify stakeholders, resources and other system elements that are common to entrepreneurship education programs. An additional case study for a technological university was described using the Service Science Canvas.

While this article contributes to research in service science, entrepreneurship and higher education management, it has some limitations. Academic systems change and evolve over time, and therefore it is important to consider their life stages. Yet, the Service Science Canvas is merely a static snapshot of an academic system. Building on the analysis proposed in this article, future research may introduce computational models similar to Zaini et al. (2016) that could simulate the dynamic evolution of a service system. Such models would incorporate complex causal interrelationships between resources, perceptions and service outcomes. Having computational representations of academic systems in the form of models would allow us to test various scenarios with the goal of identifying optimal policies.

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# Chapter 25
# Leveraging Big Data Platform Technologies and Analytics to Enhance Smart City Mobility Services

**Robin G. Qiu, Tianhai Zu, Ying Qian, Lawrence Qiu, and Youakim Badr**

**Abstract** The Internet of Things (IoT) allows objects to be sensed and managed over networks, creating opportunities for beneficial interactions and integration between the physical world, computer-based systems, and human beings. The recently enabled people-centric sensing or social sensing transforms how we sense and interact with the world. For instance, social sensing via mobile apps complements physical sensing (e.g., IoT) by substantially extending the horizon we know about our living communities and environments in real time. This chapter presents how we can integrate physical and social sensing to enable better and smarter services in great detail. With the support of big data technologies, we use city mobility services to demonstrate the great potential of the proposed data integration and aggregation. Specifically, real time data from Citi Bike and Twitter.com are collected, processed, and modelled. The developed prototype in support of city mobility management and operations shows numerous potential benefits of the proposed digital ecosystem platform.

**Keywords** Smart service systems · Smart service modeling · Smart city · Smart mobility service · Internet of Things (IoT) · Data analytics · Machine learning · Bike sharing

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_25

## 25.1 Introduction

Physical sensing is generally considered as a process that relies on physical sensors to detect, collect, and explore a physical event, activity, and/or change mechanically, electrically, or photo-electrically. With the fast development in networking technologies and material science, physical sensors have become network capable while small in size. Indeed, through the use of pervasive networking technology and the Internet the capability and applicability of sensor networks, including wireless sensor networks (WSN), have been astonishingly increased.

Not long ago, things or physical objects attached with networked sensors gave rise to the emerging concept of Internet of Things (IoT). Today, IoT is generally referred to as the assembly of a variety of networked things or objects, such as radio-frequency identification (RFID) tags, sensors, actuators, and mobile devices. International Data Corporation (IDC) defines IoT as “a network of uniquely identifiable ‘things’ that communicate without human interaction using IP connectivity” (Press 2015). IoT technologies make possible any physical object to be sensed, monitored, and/or managed over the networks, which create opportunities for more direct integration between the physical world, computer-based systems, and human beings. Today, almost five billions of things or objects are already connected through networking. Because IoT supports and promotes ubiquitous, pervasive sensing and computing, it is rapidly gaining ground and penetrating into people’s daily life at work and at home (Atzori et al. 2010; Miorandi et al. 2012; Gubbi et al. 2013).

Deloitte (2015) predicts that “IoT hardware and connectivity revenues are growing at about 10–20 percent annually, while the apps, analytics and services are growing even more rapidly at 40–50 percent”. According to IDC (Press 2015), there will be about 30 billions of IoT devices in 2020. IoT has a total potential world economic impact of over $11 trillion a year by 2025. Self-organized, adaptive, cooperative, interacting, socio-technical, and sustainable properties characterize a desirable digital ecosystem. As a result, the world becomes more and more connected, dynamic, intelligent, and sustainable. Because IoT, computing, and networking and communication technologies keep fast advancing and more and more innovative IoT applications emerge, the world would become truly a digital while well-integrated and interdependent ecosystem.

Since urbanization has been on the rise, we must make our cities smarter and more sustainable than ever before. Today, a smart and sustainable city is a socio-technical and digital ecosystem, in which people are the actors who are surely the core of the ecosystem. No matter which city we live in and what we do, we all use products and consume services to fulfill our daily work, leisure, and home needs. At the end of a day, we do not care about how and where products and services were made or enabled, by whom, and how they were delivered; what we care about is that our socio-psychological (i.e., in the social aspects of) and functional (i.e., in the technical aspects of) needs are met in a satisfactory manner (Qiu 2009, 2014). Hereinafter, a socio-technical and digital ecosystem is simply called a *service system*.

Regardless of being small and simple like a comfort control management system at home, or large and complex system like a city’s public transportation control and

management system, a service system focuses on enabling and delivering services using all available means to realize respective values for both the service provider and the service consumer. For example, because of the timely supports enabled by well-deployed physical sensing, the Edge building service system (Randall 2015) controls and manages everything from air conditioning operation, lights dimming, and room humidity level adjustment to when air filters need to be changed. By further taking advantage of people-centric or social sensing capabilities enabled in smartphones, tablets, and other mobile sensing and computing devices, the Edge building service system can further track and positively facilitate the interaction between the Edge building and its inhabitants. As a result, the Edge building becomes one of the smartest and greenest office buildings in the whole world.

Apparently, to the provider of a service system, the goal is to deliver the needed services for its end users while making sure that the service system is competitive and sustainable, technically and financially. To the end users of a service system, the goal is to have their functional and socio-psychological needs met in a satisfactory manner. Because a city is a service system on a large scale, it would not be sustainable unless intelligent city management and smart city services could be enabled to overcome the increasing urbanization pressures and challenges (De Jong et al. 2015). For example, city mobility services play an important role in city inhabitants' daily life. Smarter and greener city mobility services can thus substantially contribute to the process of improving sustainability of populous cities.

In this chapter, we study how integrating physical and social sensing would help enable some smart services in the context of city mobility services. We particularly focus on people's mobility management, which is one important aspect of urban services that make cities smarter and more sustainable. We discuss how physical and social sensing can collectively enable smart services. We explore how Big Data technologies can further enhance urban smart services and introduce our PSU-INSA smart city big data platform. We then illustrate the platform with enabled analytics using simple service scenarios based on the New York's Citi Bike program in the USA. At last, we conclude our work and highlight future work and research trends on the integration of physical and social sensing.

## 25.2 Integrating Physical and Social Sensing to Enable and Support Smart Services

Applications of physical sensing are ubiquitous. Physical sensing is also getting more sophisticated and interactive. For example, Paradiso et al. (1997) develop "a truly 'immersive', tetherless musical environment" as any kind of performer motion would be physically sensed and directly, immediately converted into expressive sound. Computationally, the performer's space position and his/her feet pressure must be computed together with his/her upper-body and hand motion. To have effective physical sensing, they use a pair of Doppler radars to capture performer's upper-body kinematics (velocity, direction of motion, amount of motion) and install

a grid of piezoelectric sensors under a carpet to measure dynamic foot position and pressure.

Physical sensing by relying on IoT makes possible the collection, processing, and computing of a variety of environmental data and information. Hence, physical sensing plays a key role in city based sensing applications. Jin et al. (2014) illustrate an information framework for developing IoT based smart city's information and communication technologies (ICT) applications. They particularly emphasize that the progress in social networking with the support of smartphone technology has enabled a new sensing paradigm, called participatory sensing (Burke et al. 2006). This paradigm can be adopted to encourage city citizens to be involved in and contribute to their city development and management. Indeed, people-centric sensing or social sensing transforms how we sense the world. Today, social sensing complements physical sensing by substantially extending the horizon we know about the world in a timely manner (Qiu 2014).

As for mobility management in a smart city, transporting city inhabitants by meeting their daily mobility needs is the city's ultimate goal. Operating public transportation systems in a safe, punctual, efficient, and cost-effective manner is essential. Nevertheless, to promote and enable smart and green mobility in cities plays an important role in making cities financially and environmentally sustainable. Over the years, we have witnessed that energy overconsumption and greenhouse gas emission have been the main culprits accelerating air pollutions and the global warming. Hence, we have a responsibility to reduce our individual carbon footprint whenever possible. When driving cars is necessary, one example of simple and effective ways for us to reduce carbon footprints is to do carpools frequently.

Another smart and green city mobility example is to promote and encourage more people to ride on bikes. For instance, Citi Bike that was launched in May 2013 is an NYC bike share system or citibike (Fig. 25.1). According to Citi Bike monthly reports (CitiBike 2017), Citi Bike memberships reached an all-time high, with over 118,950 active annual members by the end of October, 2016. A lot of tourists as casual riders also utilized the system. "On average, there were 50,763 rides per day in October, with each bike used 5.36 times per day."

Yet another excellent example in Europe is the Grand Lyon open data initiatives (Optimod'Lyon 2017), focusing on promoting smart city programs by fully leveraging the advances of ICT. More specifically, in the field of promoting and supporting greener city mobility, The city of Lyon offers a wide range of modes of low-carbon-emission transport and services. One of smart Lyon city initiatives is her bike sharing system, also called Vélo'V. With the help of physical sensing technologies, Vélo'V Station map application (Fig. 25.2) in support of smart city mobility services can provide real time information on the availability of bikes and their station information around Lyon.

In fact, a lot of cities around the world have launched many smart city initiatives. Through taking advantage of well-developed sensor-based networks and Internet technologies, physical sensing technologies have been widely adopted in many cities around the world, which essentially facilitate building and supporting real time information applications like the mobile apps for citibike (CitiBike 2017) and

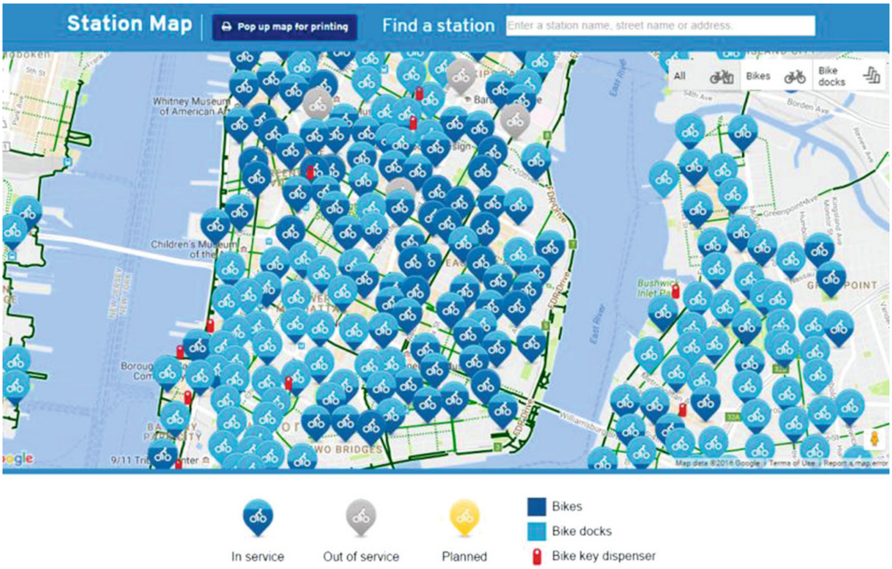


Fig. 25.1 A snapshot of the Citi Bike station map (Copyright© http://citibikenyc.com)

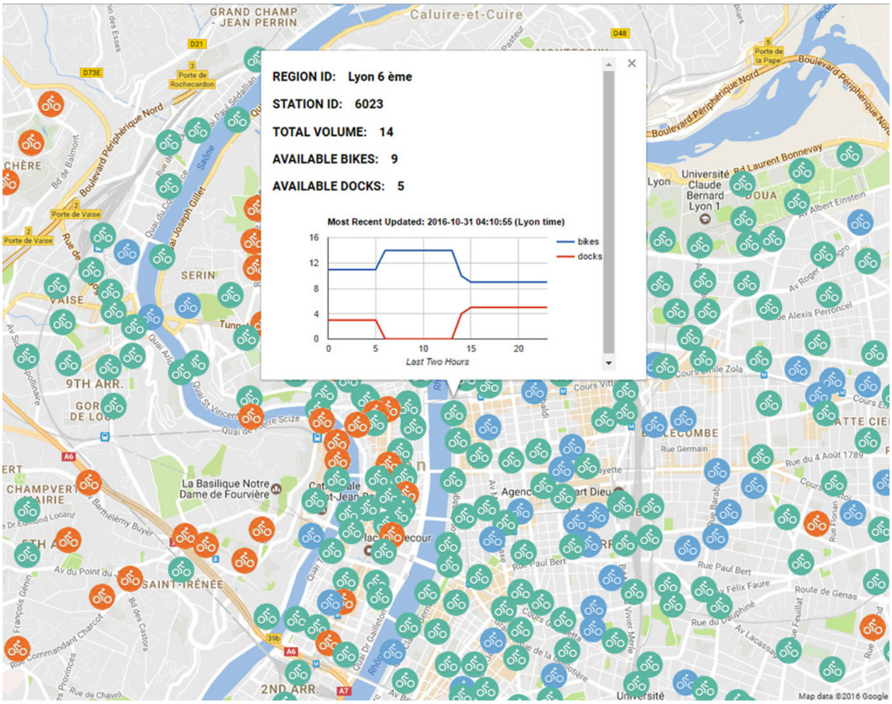


Fig. 25.2 Physical sensing data of Lyon's public bikes' and docks' availabilities

Vélo'V (Optimod'Lyon 2017) bike sharing programs. As a result, bike riders can utilize bike sharing systems in an increasing convenient and efficient manner.

City inhabitants are always enthusiastic about innovations and initiatives that facilitate building healthy and sustainable cities. The large increased ridership of citibike since its inception in 2013 is a convincing evidence. "There were 1,573,653 trips in October, with an average of 50,763 trips per day. The combined distance traveled for all trips was 3,359,566 miles", according to citibike's monthly report in Oct. 2016 (CitiBike 2017). Riding bike is a simple and effective burning-calorie exercise for keeping a healthy body. If converted, Citi Bike riders burned a total of about 140 million calories for the month. In terms of generating environmental impact, Citi Bike offset about two million pounds of carbon in October, 2016.

Evidently, physical sensing helps service providers capture, understand, and build solutions to improve and enhance services in the aspect of meeting customers' technical functional needs. In contrast, it is social (or people-centric) sensing that captures customers' socio-psychological dynamics, including daily social and work activities, interaction, behaviour, and attitudes, and accordingly helps service providers understand and identify viable and personalized solutions to enrich customers' service consumption experiences by meeting customers' socio-psychological needs (Qiu 2014). In other words, collected data with the help of both physical and social sensing can provide accurate and prompt insights in support of smart decision-making in service systems. Without loss of generality, Fig. 25.3 shows a typical conceptual framework for developing a smart service system by leveraging both physical and social sensing. Integrating physical and social sensing thus becomes essential for a service system to stay smart and competitive.

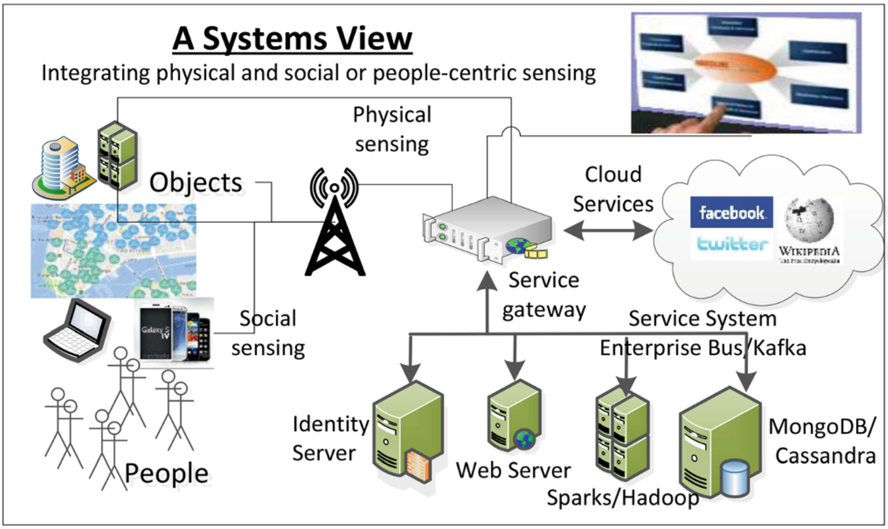


**Fig. 25.3** Integrating physical and social sensing in a smart office setting

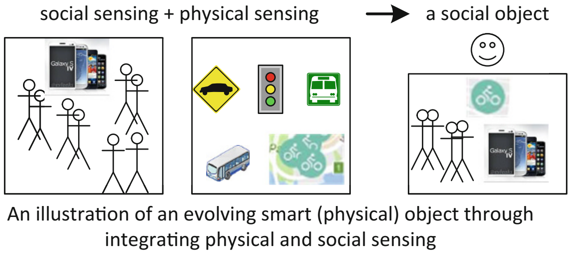


**Fig. 25.4** Evolving from smart objects to social objects

Leveraging both physical and social sensing has truly become a new trend in enabling smart services. As mobile computing devices, IoT-based networks, and corresponding applications evolve, Atzori et al. (2014) articulate that all objects (including both human beings and physical things) on the planet could be made locatable, addressable, interactive, and/or collaborative over networks and/or the Internet. Although physical objects are typically created and deployed at different designated granularity and hierarchical levels in a service system, objects can evolve and reveal desirable social behaviours when human social networking concepts and capabilities are appropriately integrated into IoT. That is to say, objects could evolve as a new generation of "smart objects", called "social objects" (Fig. 25.4), which should be "able to discover new services, start new acquaintances, exchange information, connect to external services, exploit other objects' capabilities, and collaborate" for the realization of a new common goal in a more sophisticated, social, and responsible manner (Atzori et al. 2014). Hence, objects become smart, which can potentially not only produce and/or consume services but also collaborate with each other to realize their respective values and goals.

In Citi Bike, citibike mobile apps based on physical object sensing can real time provide the needed information on the statuses of bike stations and the availabilities of bikes and docks at individual stations (Figs. 25.1 and 25.2), which can help bike riders utilize bike sharing systems in an extremely convenient and efficient manner. If riders' activities, social interactions, and service consuming behaviours and attitudes in real time can also be well considered, then bike sharing systems can be enhanced (Qiu et al. 2017).

For example, a smart service application could be developed. Before a rider heads for a bike station to get or return a bike, the information on predicted available numbers of bikes for nearby or preferred bike stations or docks at the rider' destination station can be provided in real time. If chosen by riders, personalized service recommendations at the point of need can be made available. To Citi Bike, to better serve the riders, the service provider could rely on the enabled prediction model to timely rebalance their bike inventories as needed. In the long run, by implementing effective service referrals and beneficial action resources for generating positive social changes, bike sharing systems can be made smarter and thus being utilized in a more effective and satisfactory manner, contributing to building healthy and strong cities.

Integrating physical and social sensing becomes essential for enabling smart city mobility services. In the following section, we show how big data technologies can enhance some of above-mentioned city mobility services in operation in a smarter and greener manner than ever before.

## 25.3 Service Systems Getting Smarter with the Support of Big Data Technologies

From the perspective of enabling smart city mobility services, traditional analytic approaches work well with historical data. For example, New York City weather and citibike's daily trip and bike usage data for October, 2016 (CitiBike 2017) can be easily analyzed using IBM SPSS Modeler (IBM 2017) (Fig. 25.5). It is a common sense that the better weather the more riders who used the citibike services. Note that riders are surely more interested in the real time availability information of bikes or docks at the point of need than their histories.

Varying with local weather, traffic, public transportations, on-going activities, and demographics, the demand on bikes or docks changes very rapidly from time to time and location to location. Conventional data analytic approaches provide limited results and capabilities to real time predict reliable new trends, behaviors and attitudes due to data heterogeneity, velocity of its large volumes on a large scale. Thus, a platform of collecting and aggregating real time, voluminous, and heterogeneous data must be built, which provides the foundation of enabling smart city

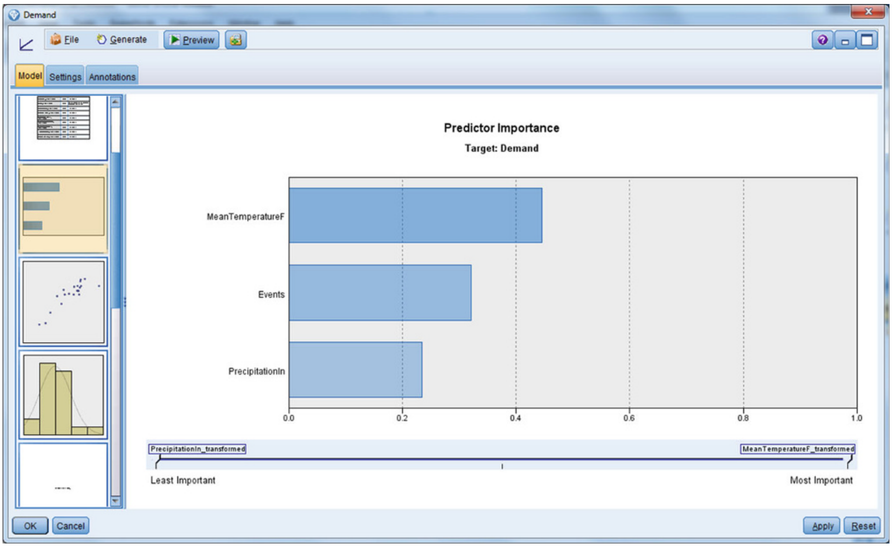


Fig. 25.5 Local weather conditions impact the usages of citibike services

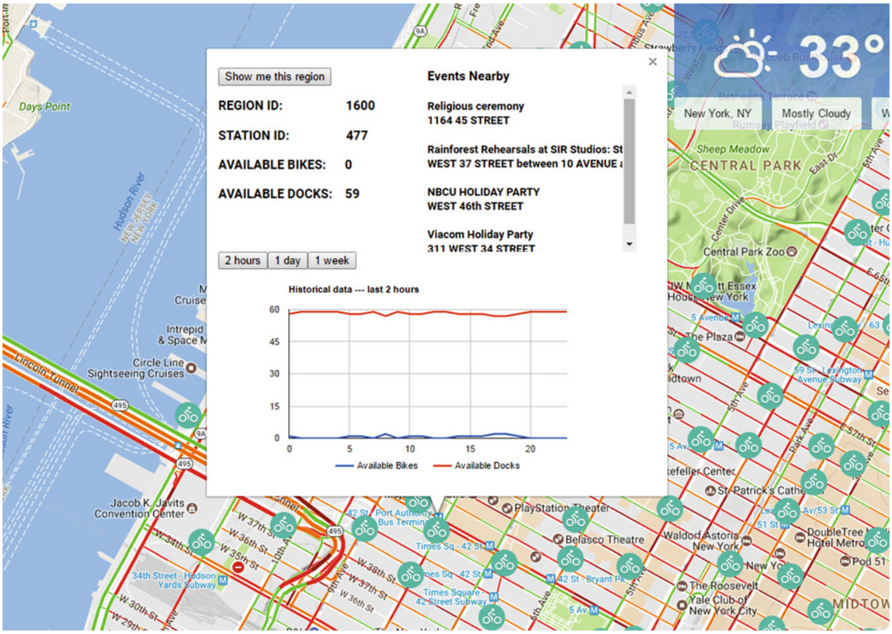


**Fig. 25.6** An example of citibike real time information services (Copyright© PSU-INSA—http://pennstatetest.mybluemix.net/)

mobility services. Using a rider's location data or profile to predict the number of available bikes of nearby or preferred bike stations can be a very promising smart service. However, the insights of how daily events impact the usages of bikes (or bike demands) at individual stations might not be easily discovered (Fig. 25.6).

IoT, mobile computing devices including smartphones, and their applications have become one of the driving forces in the future growth of the world digital economy. IoT, smartphones, mobile devices, and the Internet together have indeed transformed how the world is connected and people communicate, live, and work (Atzori et al. 2010, Miorandi et al. 2012, Gubbi et al. 2013, Deloitte 2015). Approximately 2.5 quintillion ($10^{18}$) bytes of data are generated daily, which are largely attributed to ubiquitous and pervasive uses of physical sensing (e.g., through networked sensors) and social sensing (e.g., through populous social media apps). Effective and efficient "Sense and Respond" helps service providers promptly make informed operations and management decisions and take optimal actions so as to meet their customers' changing needs. Therefore, it is necessary to explore how big data technologies can considerably enhance city mobility services in operation and develop new and smart services over time.

Because of the availability of massive data, an array of advanced analytical methods and techniques come into being, making possible extracting insights from big data and understanding customers' socio-psychological needs with previously unachievable levels of sophistication, accuracy, efficiency, and effectiveness

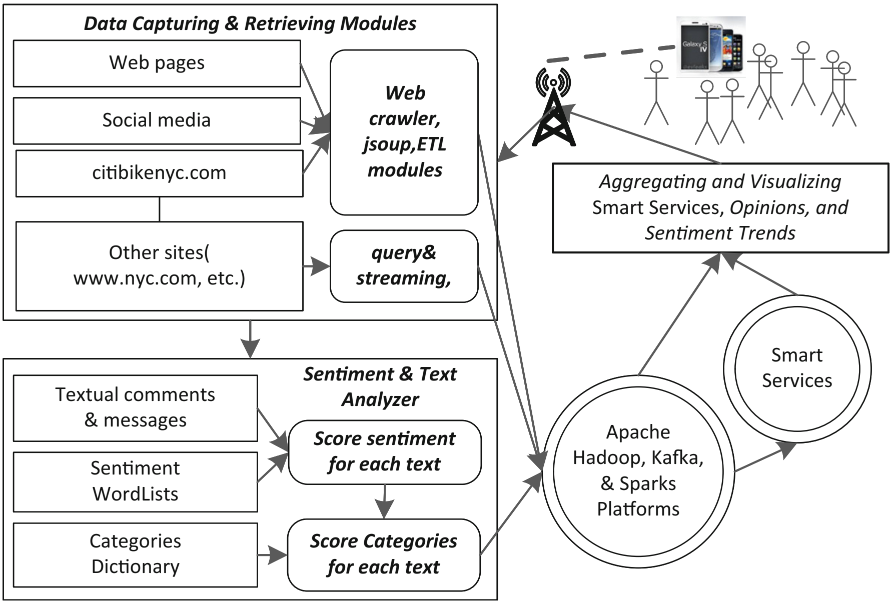


**Fig. 25.7** PSU-INSA big data platform of enabling smart mobility services

(Schroeck et al. 2012). For example, a computational approach is proposed to model a generic service system by taking consideration of people's physiological and psychological needs, cognitive capabilities, and sociological constraints (Qiu 2009, 2014). Integrating physical and social sensing is essentially the proposed approach's fundamental enablement. However, without collecting and aggregating the massive data on people's activities, interactions, behaviours, and attitudes in real time, "objects" in a service system could never computationally evolve into "smart objects" or "social objects" to strive for their common goals. In the context of operating and managing smart city's mobility services, we present our citibike project as an example to show how a service system can get smarter with the support of big data technologies (Fig. 25.7).

As shown in Fig. 25.7, six main computing components (Qiu et al. 2016) in support of smart city mobility services are briefly summarized and explained as follows:

- Data capturing and retrieving supports: Web crawler, data extract-transform-load, and tweets query and streaming modules are developed, deployed, and utilized for retrieving and pre-processing data from different and heterogeneous data sources over the Internet, including users' social interaction inputs from mobile applications. As a result, both physical and social sensing data are captured and collected.
- Sentiment and text analyzer: Collected and archived data and information are transformed and analyzed to generate sentiment scores (Fig. 25.8) and topic

| | | |
|---|---|---|
| 90 | At @BrooklynCB6 Citibike mtg: top reason against docking stations is to protect free parking, even tho so few spaces lost in program @Bahij | -0.6275 |
| 91 | Current speaker is talking about being fed up with politicians. Upset that her comments did not convince DOT. #citibike #cb6 #bikenyc | 0.1250 |
| 92 | RT @bradlander: I'm live-casting the standing-room-only @BrooklynCB6 hearing on Citibike on my Facebook page (if you could not get in). | 0.1013 |
| 93 | @ddartley no. Each is a Citibike station. Then based on the number of docks, you can estimate number or parking spots | -1.1250 |
| 94 | Speaker says #citibike conversation mirrors others we have in Brooklyn, that "change is hard." #cb6 #bikenyc | 0.3527 |
| 95 | "Carroll Gardens has been taken over." #citibike Says need police to stop taking parking spots. #cb6 #bikenyc | -0.7734 |
| 96 | RT @AmandaMcCormick: 60,000 bikes checked out in bk CB6 since #citibike rollout here at a cost of 76 parking spaces (3/4 of 1% of all space… | -0.1250 |
| 97 | RT @bradlander: I'm live-casting the standing-room-only @BrooklynCB6 hearing on Citibike on my Facebook page (if you could not get in). | 0.1013 |
| 98 | Crowd getting restless. Shouting down speaker who says few spots were removed. #citibike #cb6 #bikenyc | -1.3438 |
| 99 | RT @IQuantNY: Citibike usage per spot > cars in most parts of Carroll Gardens and Park Slope. https://t.co/27Xg9qm5b2 (cc @StreetsblogNYC… | 0.4054 |
| 100 | Lots of speakers have both bikes & cars. say they need parking. But so do bikers. #citibike addresses lack of bike parking. #cb6 #bikenyc | 0.0710 |

**Fig. 25.8** An example of sentiment scores of citibike riders

concepts, aimed at identifying service performance trends and public preference changes in a collective and/or an individual manner over time.

- Big data computing cluster platforms: Apache Hadoop and Spark platform technologies based on Lambda architecture are used to aggregate, consolidate, and archive the captured and pre-processed sensing data and the results from the sentiment and text analyzer.
- Citizens' mobility smart services: service modeling tools and methodologies (i.e., social computing and analytical algorithms) are applied for generating customized smart mobility services in real time based on archived and on-going, newly collected and updated data.
- Visualization modules (Fig. 25.6): interactive web interfaces are developed and deployed to allow end users to visualize aggregated public opinions and sentiment trends and enabled city mobility management services (please check out our demo website hosted by IBM Bluemix, PSU-INSA—http://pennstatetest.mybluemix.net/).
- Mobile applications (Fig. 25.9): end users' mobile apps help riders understand the recommended mobility choices on a daily basis, and allow them to provide feedback on the provided smart services and update personal choices and new preferences as needed.

Evidently, analyzing massive volumes of heterogeneous data sets in real time plays a key role in not only managing and delivering services in smart cities to meet

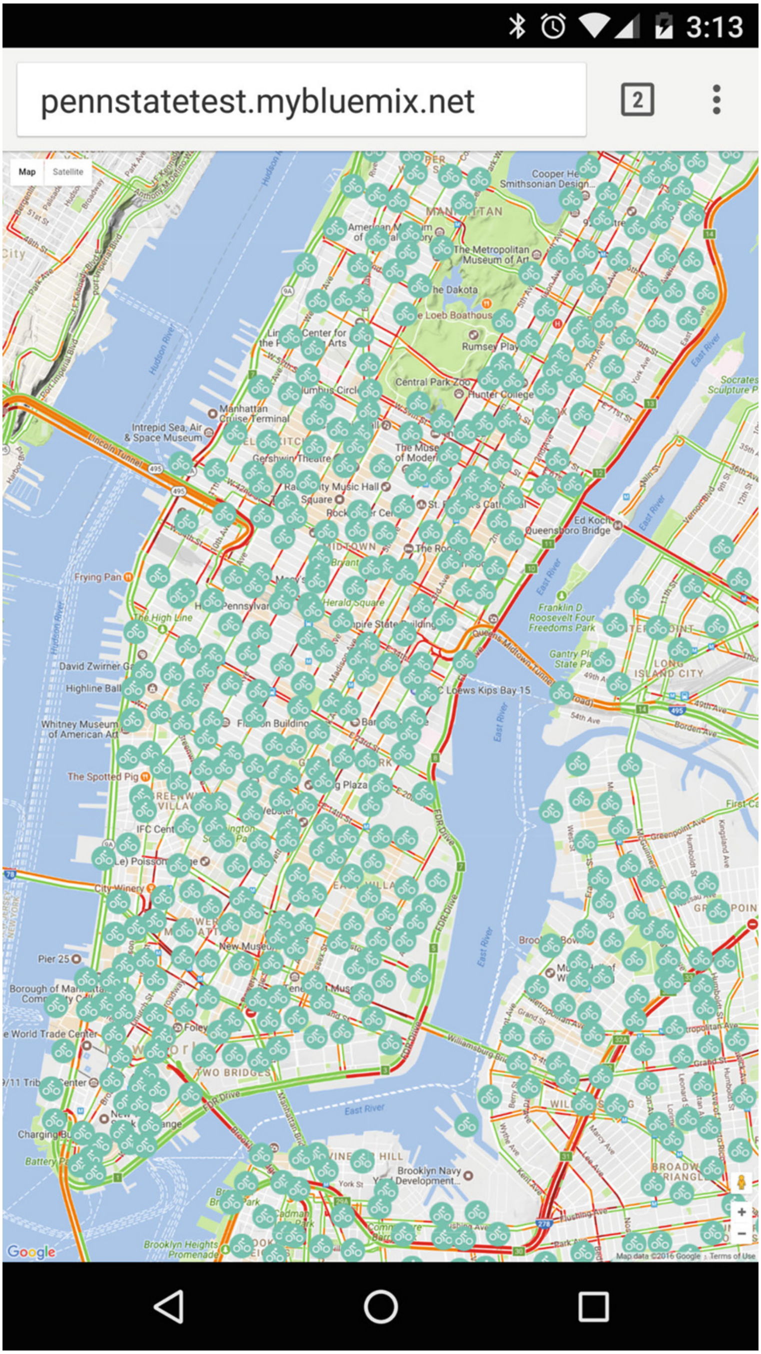


Fig. 25.9 An Android app view of bike stations and local traffic information

inhabitants' needs but also understanding and predicting their behaviors and future needs. As shown in Fig. 25.7, big data technologies are essentially adopted for large scale analytical purposes in this project, which underpin the discovery of insights into inhabitants' experience, attitudes, and perception regarding the development of new public and economic services.

Indeed, service innovation in support of smart cities requires new analytical approaches to modeling socio-technical aspects of service systems in operation, which helps us capitalize on real time analytics using massive amounts of heterogeneous data and design and develop innovative services. Promisingly, with the support of the fast advances in big data technologies, city mobility management services in a smart city can be truly made real time, scalable, and adaptable. The deployed "social objects" can be further integrated and aggregated collaboratively and socially to meet the needs of continuing global urbanization. As a result, mobility management service systems will be able to provide city inhabitants more and much smarter services as time goes, meeting cities' changing and challenging needs, technically, financially, and environmentally.

## 25.4 Analytics for Smart Mobility Services That Makes a City Green and Sustainable

As mentioned earlier, urbanization has been on the rise around the world. According to UN Habitat (UN-HABITAT 2017), more than half the world's population lives in cities. The global urban population is expected to rise to 70% of the world population by 2050. It requires innovative approaches to improving and maintaining appropriate and sustainable city infrastructure, such as healthcare, telecommunications, transportation, energy, and water, and waste management, to keep up with the increased needs of urban inhabitants. Cities will surely have more and more impacts on the environment and climate change.

Garschagen and Romero-Lankao (2015) articulate that urbanization can have nuanced effects on overall city vulnerability. Promisingly, cities around the world have started to explore a variety of solutions to upgrade urban infrastructure and services in operation, aimed at creating improved environmental, social, and economic conditions. According to the study conducted by de Jong et al. (2015), over the last couple of decades the engaged initiatives for enhancing cities' attractiveness and competitiveness around the world can be classified into twelve dominant categories. Top priorities are consistently focused on city's sustainability and smart services by fully leveraging the advances of ICT.

Let's explain how real time predicting the availability of bikes and docks for individual stations as one of citibike's smart service examples can be enabled and supported in our PSU-INSA big data platform. A resultant service scenario is as follows:


**Fig. 25.10** An example of provided real time station information

- To a rider as a service customer, at the point of need, he/she has the confidence of getting a bike or returning his/her bike before the rider heads for a bike station he/she chooses (Fig. 25.10);
- To Citi Bike as the service provider, the deployed prediction model can be effectively applied to controlling and managing bike inventories in a timely manner (Fig. 25.11), so as to warrant the riders' confidence of service deliveries.

As shown in Fig. 25.7, real time station data, NYC daily events (NYCDE 2017), and tweets that are hash tagged with citibike are retrieved, processed, and aggregated. PSU-INSA has archived Citi Bike station data since the summer of 2016. In addition, all historical systems and trip data can be downloaded from citibike website (Citibike 2017). Without loss of generality, we used one week data (from October 10 to 16, 2016) to show how a simple bike demand prediction model for a citibike station. A time series (TS) node from IBM SPSS Modeler was applied to this predictive analytics problem. Figure 25.12 illustrates how TS models was developed using IBM SPSS Modeler.

Using a bike station labeled as 3263 as an illustrative example, in Fig. 25.13 we show how well TS models can perform its bike demands modeling for the week. The prediction model was created by applying an ARIMA TS model with parameters of non-seasonal $p = 1$, $d = 0$, $q = 0$; seasonal $p = 1$, $d = 0$, $q = 0$ to the station (IBM

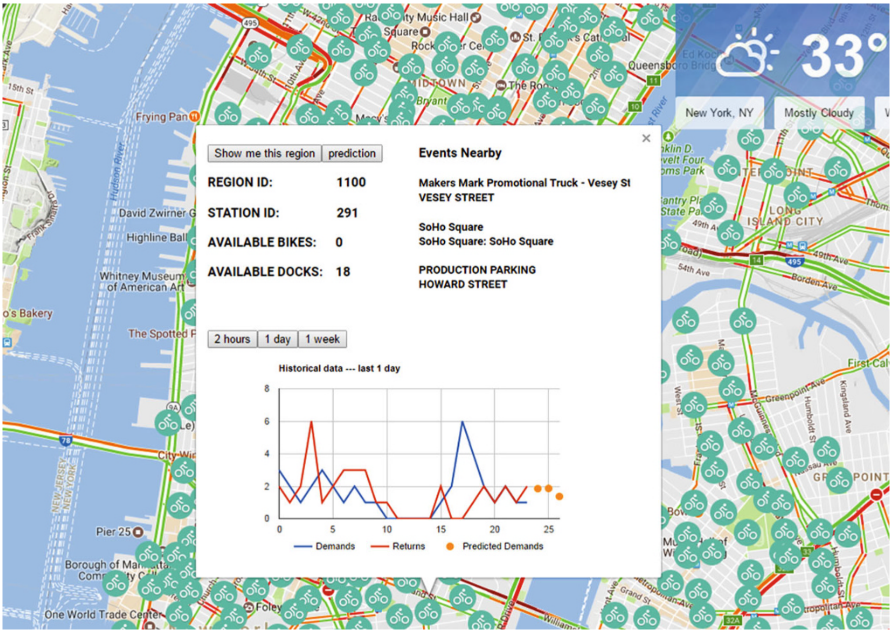


Fig. 25.11 An example of predicted bike demands at a station

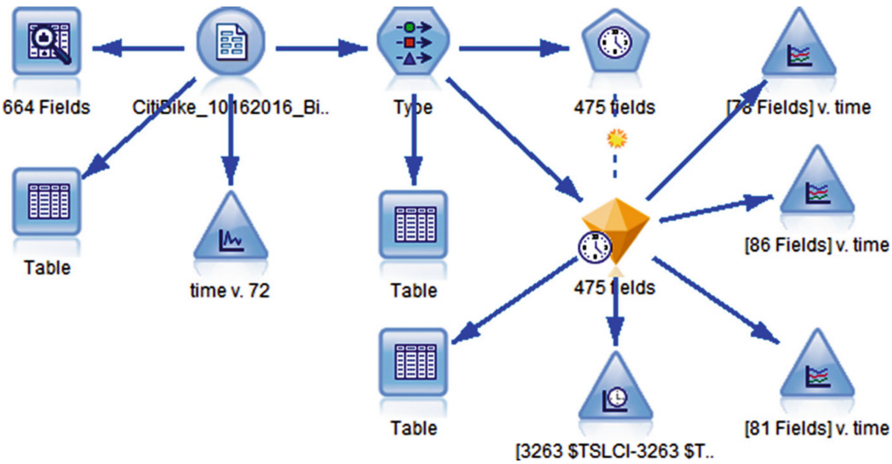


Fig. 25.12 An example of predicting bike demands using IBM SPSS Modeler

2017). Figure 25.14 displays the model's autocorrelation function (ACF) and partial autocorrelation (PACF) plots with 95% confidence. It clearly indicates that the TS model fits well with the collected data. Table 25.1 gives the parameter estimates for the ARIMA (1,0,0)(1,0,0) model for station 3263. Therefore, the developed TS model can be used to predict the future bike demand for bike station 3263.

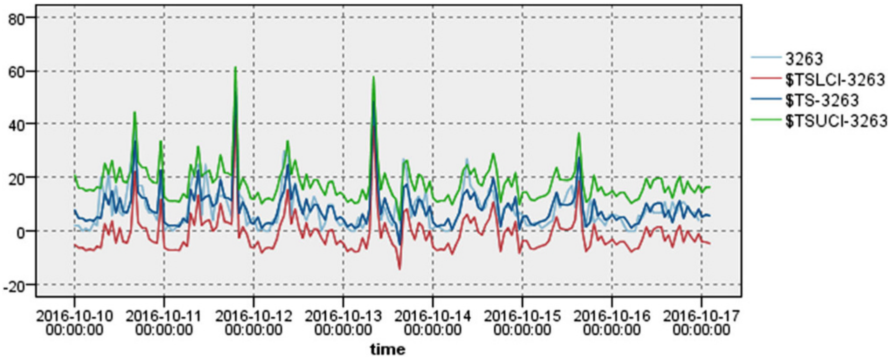


**Fig. 25.13** An example of bike demand modeling using TS models

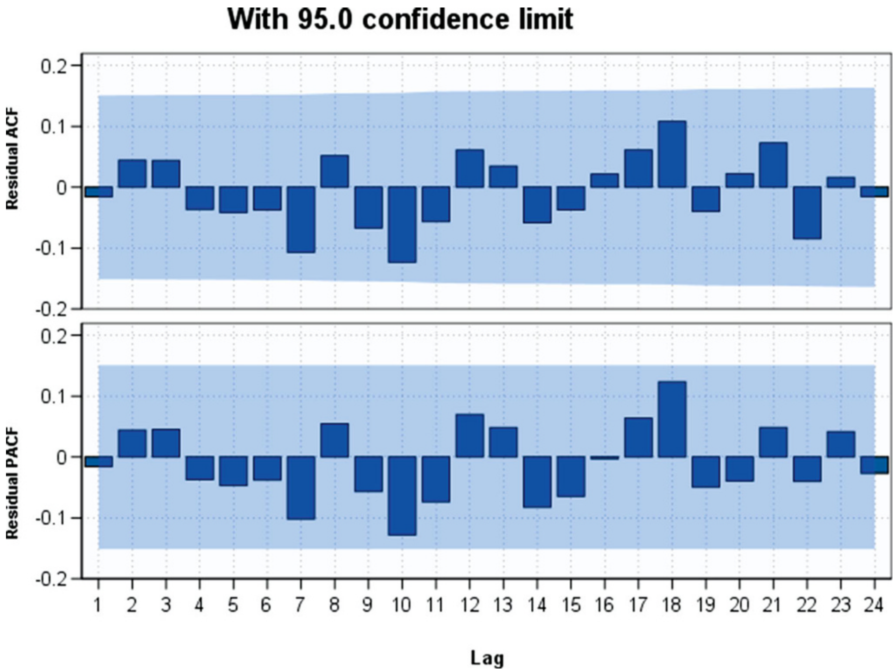


**Fig. 25.14** Correlogram of ARIMA (1,0,0)(1,0,0) model for bike station 3263

**Table 25.1** Parameter estimates

| | Coefficient | Std. error | t | Significance |
|---|---|---|---|---|
| Constant | 7.891 | 1.461 | 5.400 | 2.392E−007 |
| AR | −0.510 | 0.069 | −7.373 | 8.628E−012 |
| AR, seasonal | −0.579 | 0.063 | −9.221 | 2.220E−016 |

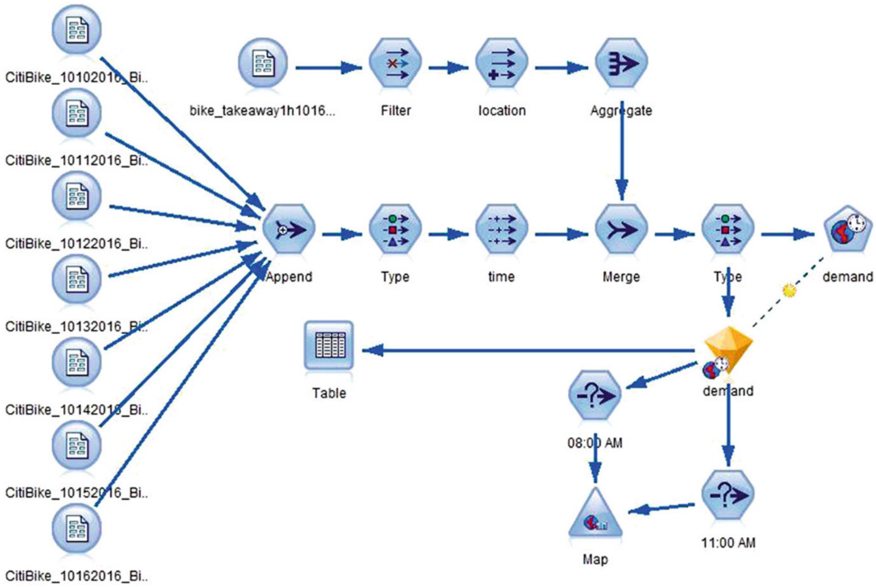


**Fig. 25.15** An example of citibike bike demand STP modeling using IBM SPSS Modeler

Typically, to a rider, he/she is quite satisfied as long as he/she can get a nice bike at the point of need or quickly return it at his/her destination. To the service provider, in addition to maintaining stations and bikes well, bike rebalancing operations to maximally meet the needs of the bike availability across all bike stations is challenging. According to citibike's monthly report in Oct. 2016 (CitiBike 2017), Citi Bike staff rebalanced about 4000 bike daily. The developed big data platform to enable and support effective analytics of bike rebalancing in a timely manner is essentially needed.

In the remaining section, we show a way of developing the needed model in support of rebalancing operations in a dynamic and optimal fashion. Using IBM SPSS Modeler, we developed a spatiotemporal prediction (STP) model of bike demands across all bike stations to support the citibike service system (Fig. 25.15). When we compared bike demands at two different times, e.g., from 8:00 AM to 11:00 AM on October 11, 2016, we can visualize the changes using the map visualization support in IBM SPSS Modeler. As shown in Fig. 25.16, the size of a circle is proportion to its demand at an individual station that is labeled by a number; circles in red reflected the demands at 8:00 AM while circles in green reflected the demands at 11:00 AM on October 11, 2016.

Different from individual station demand modeling that is typically station-based and focuses on riders' needs, Citi Bike as the service provider is most likely interested in capturing and predicting bike demands based on predefined regions or groups, aimed at facilitating rebalancing operations from time to time. As illustrated in Fig. 25.16, significant changes can be aggregated based on regions or

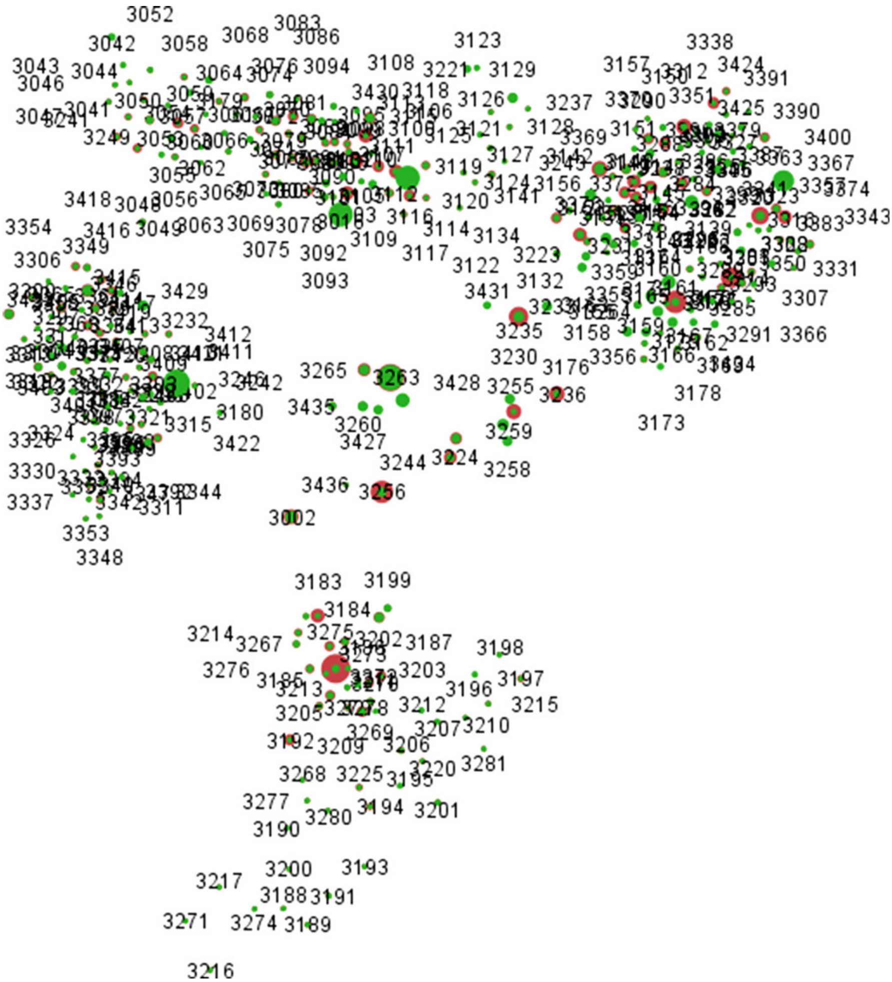


**Fig. 25.16** Bike demand changes from 8:00 AM to 11:00 AM on Oct 11, 2016 using the map visualization support in IBM SPSS Modeler

groups. The information on predicted available numbers of bikes for regions or groups can be provided in real time, which can then help Citi Bike staff to rebalance bikes using trucks or bike-trailers. In reality, even though regions or groups demands would be accurately predicted, dynamically optimizing bike rebalancing operations to meet the needs with constrained conditions and resources at a given time (e.g., weather information, traffic situations, and available staff, trucks, and bike-trailers) could be another challenging problem, which will be surely one of our future research topics.

To further enhance the above-discussed smart city mobility services, public opinions from social media, including twitter.com and Facebook, can be aggregated

and incorporated into our prediction modelling in real time, Citi Bike thus could know their customers and citizens' real issues and needs from time to time, so better and improved services could be created and enabled as time goes. Promisingly, in the long run, by implementing effective service referrals and beneficial action resources for generating positive social changes, we can make bike sharing systems smarter and thus being utilized in a more effective and satisfactory manner, contributing to building healthy and strong cities.

## 25.5 Conclusions and Future Research Highlights

As discussed earlier, the global urban population keeps rising. Without innovative approaches to improving and maintaining appropriate and sustainable city public infrastructures, such as healthcare, transportation, energy, and water, and waste management, to keep up with the increased needs of urban inhabitants, cities might not be able to sustain over time. Promoting and encouraging use of electric vehicles (EV) (Qiu et al. 2014) and bikes in cities is considered as a viable approach to addressing part of the challenges of developing smart and sustainable cities.

The intention of this chapter is to explore a digital ecosystem framework for integrating physical and social sensing to enhance and empower service systems in general. In fact, cities around the world have launched many smart city initiatives. In particular, we showed how PSU-INSA big data platform could be adopted in enhancing citibike mobility services in a smarter and greener manner. We will explore how social interactions can be leveraged for further improving citibike services.

As our second test city, Lyon's Vélo'V would be fully investigated using the developed platform. According to Optimod'Lyon (2017), in addition to the above-mentioned EV and bike sharing programs, The city of Lyon offers a wide range of modes of low-carbon-emission transport and services. Optimod'Lyon aims "to collect, centralise and process the whole urban mobility data on a unique platform, and to create innovative services which will facilitate travels and life of users." Thus, we will collaborate with Optimod'Lyon to explore more and smarter services, which will surely help confirm the applicability of this proposed platform.

In addition, in the future work we will further explore how to promote and develop crowd sensing or social sensing based platforms by capturing and deciphering the market trends and social dynamics in real time, so better policies or regulations could be proposed and implemented in influencing the public to promote the maximum use of environment-friendly transport modes including bikes and EVs. More specifically, we will enhance our on-going research by fully taking into consideration city social events, weather forecasting, and demographics information in our future smart city mobility service modeling, design, and implementations.

**Acknowledgment** This work was done with great support and help from the Big Data Lab at Penn State. The project of *Big Data Platform (Massive Data) for Proactive Analyses of Behaviors of Users in Urban Worlds* is financially supported by the Rhône-Alpes Region, France (CMIRA2015/

15.005426). This project was also partially supported by IBM Faculty Awards (RDP-Qiu2016: IBM784769020—*Data Analytics in support of City's Smart and Green Mobility Services*, RDP-Qiu2017: IBM2305939850—Temporospatial Analytics to Enable Smarter City Mobility Services).

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# Chapter 26
# Population Health as a Network of Services: Integration of Health, Education, and Social Services

**William B. Rouse, Kara M. Pepe, and Michael M. E. Johns**

**Abstract** This chapter focuses on how population health can be conceptualized and managed as a large multi-level network of services. Specifically, how can we deliver the health, education, and social services to keep a representative population healthy within the highly fragmented US delivery system? A central consideration is the coordination of care, ranging from prevention and wellness, to chronic disease management, to acute care and managing the transition of patients from hospital to home, as well as from home to follow up visits and social services. This chapter addresses the issues and possible model-based solutions to successfully managing this whole process. A case study of substance abuse is discussed.

**Keywords** Population health · Service supply chains · Care coordination

## 26.1 Introduction

The seemingly endless debates about the costs of healthcare in the US might lead one to believe that the goal is adequate care at acceptable cost. However, 17% of the GDP—in our current system of delivery—is apparently insufficient to provide adequate care, at least not for everyone. Perhaps the goal is the problem. Instead, we should strive for a healthy, educated, and productive population that is competitive in the global marketplace, and transform the delivery system accordingly. Figure 26.1 suggests how this might be done.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_26

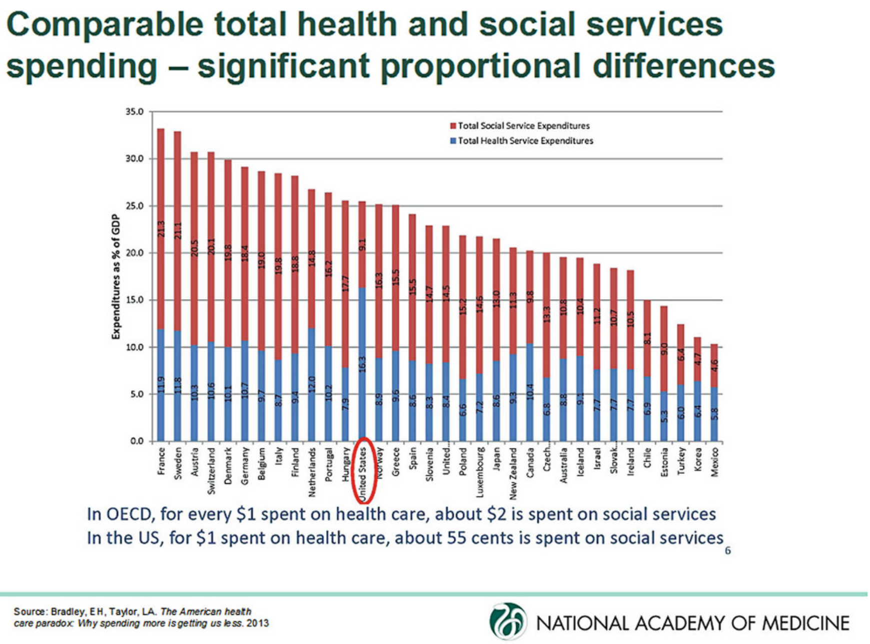


**Fig. 26.1** Health and social services spending (Bradley and Taylor 2013)

The failure of the US to spend adequately on social services results in greater needs for healthcare services and a less healthy population. We underinvest in services that could keep people healthier and wait to provide services when health states are more dire. In other words, we put off preventative maintenance and wait to perform expensive corrective maintenance.

Beyond the apparent American tendency to defer maintenance in general, e.g., of roads, bridges, and tunnels, an important reason for the lack of integrated population health services is the significant fragmentation of the overall system. Having providers, payers, and regulators, at federal, state, and local levels, results in a rather ad hoc grab bag of services, yielding a landscape that is very difficult to navigate, particularly for those at the lower end of the socioeconomic spectrum.

This chapter addresses this fragmentation and proposes means to creating integrated services without having to integrate all the providers, payers, and regulators of health, education and social services, i.e., without needing a single payer system. We draw upon principles of supply chain management within an overall health economic framework that considers both the macroeconomics and microeconomics of the overall service delivery network, as well as decision making by patients, providers, and payers. We illustrate the proposed approach in the context of addressing the epidemic of substance abuse.

## 26.2 Population Health

We advocate a very broad view of population health, namely, that it involves integration of health, education, and social services to keep a defined population healthy, to address health challenges holistically, and to assist with the realities of being mortal.

From this broad perspective, what are the contributors to population health? Lifestyle behaviors, environment and genetics play roles in disease incidence and progression. Healthy lifestyles can enable health and well being. Beyond these obvious direct contributors, education provides relevant knowledge and skills. Jobs and opportunities enable income and health aspirations. Safe and supportive communities provide access to housing, transportation and medications, as well as confidence in access. Finally, of course, quality affordable healthcare needs to be timely and effective.

What do we really know? This leads to more questions. How much sickness and disease are avoidable? How does income affect disease incidence and progression? How does education affect disease incidence and progression? How do income and education affect the prevalence of lifestyle challenges? How does money flow for health, education and social services? We do not answer these questions in general, but later provide detailed answers for addressing substance abuse.

What are the likely consequences of successful population health—the upsides and downsides? Population health initiatives, if successful, should reduce sickness and disease. Thus, fewer people will become patients needing hospital services. Hospital revenues will decrease, leading to repurposing or shedding of capacity. Providers' overhead costs will be spread across fewer transactions; hence, prices will likely increase significantly unless the number of providers decreases. People in general will be better off; those who need hospitalization may pay dearly, either directly or indirectly.

The last bit of this line of reasoning suggests that transforming our health system from acute care to population health will face significant hurdles as various stakeholders see their roles and business models disrupted. There will be inherent pushback. A model-based approach can provide the means for stakeholders to have a systemic, evidence-based dialog to inform eventual decisions.

### *26.2.1 Background*

It is useful to begin with a bit of background concerning how the population health discussion emerged. As defined by the Centers for Medicare and Medicaid Services (CMS), an Accountable Care Organizations (ACO) is a "group of doctors, hospitals, and other health care providers, who come together voluntarily to give coordinated high quality care to their Medicare patients." If they can reduce the costs of care for these patients, relative to a defined baseline, they can earn a share of the savings if

they also satisfy a range of quality metrics. CMS (2015) defines a shared savings and losses and assignment methodology in great detail. A key point is that the baseline is redefined each year, making earning the bonuses increasingly difficult. Nevertheless, the percentage of Americans having access to one or more ACOs has steadily increased (Wyman 2014), despite serious questions on the economic efficacy of the program (Schulman and Richman 2016).

The ACO program provides an incentive for a coordinated effort of care for patients—less duplicative and/or unnecessary exams, tests, etc. In 2011, Medicare made almost no payments to providers through alternative payment models. However, we are slowly shifting from volume-based fee for services to payment schemes based on value. In January 2015, Sylvia Burwell, Secretary of the US Department of Health and Human Services, announced the goal of having 85% of all Medicare fee-for-service payments tied to quality or value by 2016 and 90% by 2018 with 30% and 50% achieved through alternative payment models respectively (Burwell 2015).

Fee-for-service ACOs represent business process improvement in that providers attempt to streamline and tune their processes to incrementally reduce costs while not sacrificing quality. In contrast, population health, in its fullest sense, provides a broad vision for a healthy and educated population (Wen 2016). This will require transforming the enterprise across a variety of businesses and agencies.

Population health has been defined as “the health outcomes of a group of individuals, including the distribution of such outcomes within the group” (Kindig and Stoddart 2003). The concept of population health signifies a change in improvement at the individual level to one that is focused on improving the health of an entire targeted human population. One of the biggest priorities in achieving the shift to population health is reducing health disparities among different population groups due in large part to social determinants of health (Shortell and Casalino 2008).

Societal health is more than the absence of disease and is created through the conditions and collective actions of our daily lives. It goes beyond healthcare to look at social, financial and other factors that influence health. Social determinants of health are conditions in the social, environmental, cultural, and physical environment in which people are born, live, work and age.

In the United States, it has been found that social factors including education, racial segregation, social supports and poverty accounted for a disproportionate number of deaths—over one third of total deaths per year (Galea et al. 2011). The United States experiences a direct relation between increased premature deaths as income goes down. Similarly, lower levels of education are directly related to lower income as well as a greater likelihood of smoking and shorter life expectancy (Marmot et al. 2008; Cooper 2016).

The identification and awareness of such differences amongst populations regarding health outcomes and determinants are critical in reducing disparities and achieving health equity through a system of broad based population health. Much research has shown a great disparity in the access as well as quality of care based on geographic location. Such variation amongst states and health care regions extends further to include fundamental measures such as having health insurance or a

connection to a regular source of care such as a primary physician (Radley and Schoen 2012).

ACOs and hospitals, as a coalition, could take on very important roles in population health, although they alone are not likely to have the incentives or capabilities to effect the fundamental changes that population health implies (Casalino et al. 2015). Academic health centers can play a major role, but are unlikely to be able to deliver the full range of services (Curran 2013; Johns et al. 2016). The coordination and delivery of the needed range of services will be a challenge due to the fragmented nature of the delivery system. Enterprise transformation will be needed to understand and make sense of the highly fragmented system that delivers healthcare, education, and social services (Rouse et al. 2017).

## 26.3 Service Supply Chains for Population Health

The services needed to address population health are much broader than the services traditionally associated with healthcare. Consequently, the population health service supply chain is much richer than just providers, suppliers, and payers for health services. Figure 26.2 portrays the government agencies involved in providing these services.

Clearly, the fragmentation of the delivery system is an enormous problem. Most patients are completely unprepared to deal with the system portrayed in Fig. 26.2. As our case study later illustrates, the range of stakeholders involved in addressing substance abuse presents yet further complications.

Our approach to addressing the complexity of Fig. 26.2 draws upon macro and microeconomics, service supply chain management, and behavioral economics. Managing supply chains of services poses different problems than flows of component parts to OEMs or foodstuffs to grocery shelves, e.g., (Desai et al. 2017).

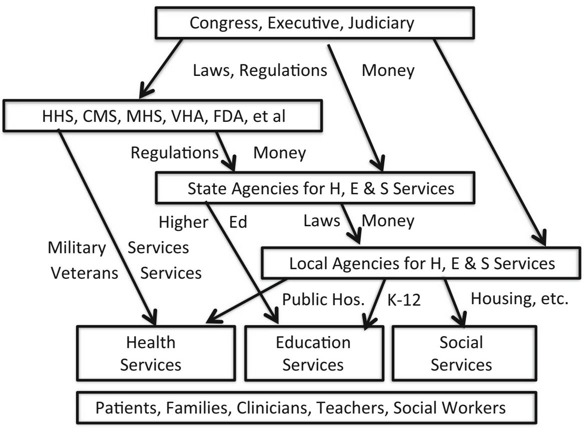


**Fig. 26.2** Relationships among organizations and services

### 26.3.1 Service Supply Chains

Voudouris et al. (2008) address service supply chain management in terms of "optimized forecasting, planning, and scheduling of the service chain (internal or external) and its associated resources such as people, networks, information, and other tangible (or intangible) assets." They emphasize the need to be human-centric and advocate the same metrics as introduced later for queuing systems.

Wang et al. (2015) provide a very extensive review of operations research methods and tools applied to service supply chain management. They distinguish service only supply chains from product service supply chains. The latter has received much more attention. Sakhuja and Jain (2012) provide a broad conceptual model, and also offer a literature review of service supply chains.

Choi et al. (2016) discuss risk management and coordination in service supply chains. They consider outsourcing, information sharing, incentives alignment, and risk analysis, including sources of uncertainty and disruptions. They note that financial risks due to uncertainty and disruptions can influence pricing. Ellram et al. (2004) address strategies for mitigating outsourcing risks include increasing visibility and the relative strength of service supply chain management, revisiting the division of labor, aligning incentives (or at least making them explicit), and installing business controls to improve visibility into outsources activities.

Considering service supply chains in healthcare, Yap and Tan (2012) address healthcare organizational performance, which they define as including quality of healthcare delivery, cost, promptness, safety, effective and efficient diagnosis and treatment, reduced process/procedure times, and internal customer satisfaction. Their review of the literature concludes that supply chain innovation and efficiency is positively related to organizational performance. Baltacioglu et al. (2007) report that enhanced information sharing, coordination, and synergy among entities result in decreased lead times, inventories, and costs in hospitals. Al-Saa'da et al. (2013) report that the quality of service supply chains correlates significantly with healthcare service quality.

### 26.3.2 Problems in Population Health

Two service supply chain problems are of particular importance to population health. The first problem is "passing the baton" to get the patient, or maybe just a participant, to the next service with all the information needed to facilitate this service. The baton is often dropped. The service chain quite likely involves disparate organization's whose objectives may be far from aligned. Success for the organization is typically defined as successful completion of the step for which an organization is responsible. Success for the patient, however, involves successful completion of all steps. Quite often, assurance of overall success is left to the patient, who in many situations is unlikely to be capable of performing the task.

The second problem is "service coordination" across service supply chains. Difficulties arise when any step in the service chain identifies a needed service unrelated to this chain. It might be an unrelated medical need or perhaps a social need such as housing. Often there are gaps between service chains that hinder providing integrated services. A key driver of this complexity is the simple fact that the network does not know what services are needed until servicing begins. Only then does the counselor, for example, discover that the patient does not have a home address.

#### 26.3.2.1 Summary

Service supply chain management is an offshoot of traditional supply chain management of flows of component parts to OEMs or foodstuffs to grocery shelves. The fragmentation of delivery systems for health, education, and social services results in supply chain management being enormously complex. Both "passing the baton" and "service coordination" will be key to successful population health.

## 26.4 Framework for Modeling

Our approach employs a framework we have developed for modeling complex social enterprises (Rouse 2015), and applied in domains ranging from healthcare delivery (Rouse and Cortese 2010; Rouse and Serban 2014) to higher education (Rouse 2016).[1] This framework addresses the physical, human, economic, and social phenomena underlying complex social enterprises. A population health version of this framework is shown in Fig. 26.3.

Key elements of this framework include:

The society level is concerned with the macroeconomics of population health, which includes the overall costs of the network of services—that is health, education, and social services—as well as costs of delivery and information infrastructures. Ideally, this level also includes consideration of revenues from healthy, educated, and productive populations, i.e., population health leads to healthy populations producing revenues far in excess of costs.

The organization level addresses the microeconomics of population health from the perspectives of providers, payers, and regulators. At this level, resources are allocated to service delivery capacities, as well as supporting infrastructure. Also important are structural relationships among organizational entities.

Both the society and organizational levels include consideration of network governance, which for population health in the US is more loosely structured, e.g.,

[1] It is easy to imagine additional levels in Fig. 26.3. For example, one might add the ecology within which a society operates, particularly if that were a major constraining factor.

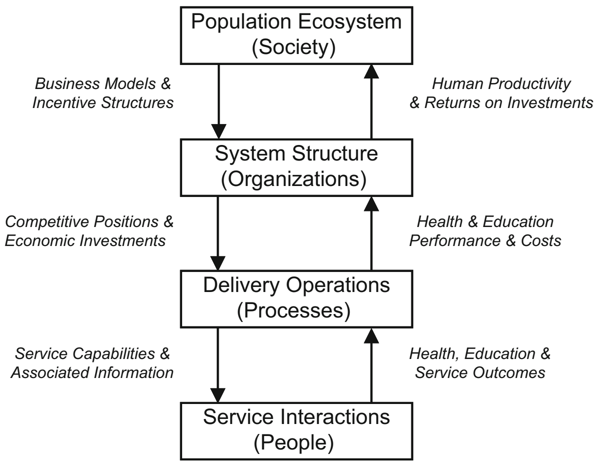


**Fig. 26.3** Population health enterprise

like the Internet, than would be a monolithic agency or corporation. The fragmentation of governance, coupled with the fragmentation of information systems, is a major challenge for population health.

The process level addresses operation and management of network flows of people, materials, information, and money. Processes deliver services and associated information to the people levels, and capture information on outcomes and costs from the people level. Interoperability of information systems is of particular importance at the process level.

The people level includes the decision making of clinicians, teachers, social workers, etc., and the behavioral economics of consumers, patients, and families, as well as the incidence and progression of states of health, education, and social status, including employment, housing, etc. Models at this level are particularly driven by theories of medicine, education, and social sciences.

The multi-level framework in Fig. 26.3 provides the basis for integrating different types of models. The people level is usually agent-based, laced with both decision theory and behavioral economics. The process level is represented as networks of flows. The organizational level involves the microeconomics of resource allocation, again laced with both decision theory and behavioral economics. The level of society involves the macroeconomics of policy. The resulting multi-level model is typically embedded in an interactive visualization that enables experimentation (Rouse 2015).

As shown in Fig. 26.4, each level is usually, in itself, a network. Thus, population health can be seen as a multi-level network of networks. This makes "passing the baton" and "service coordination" rather difficult and very important if population health is to succeed.

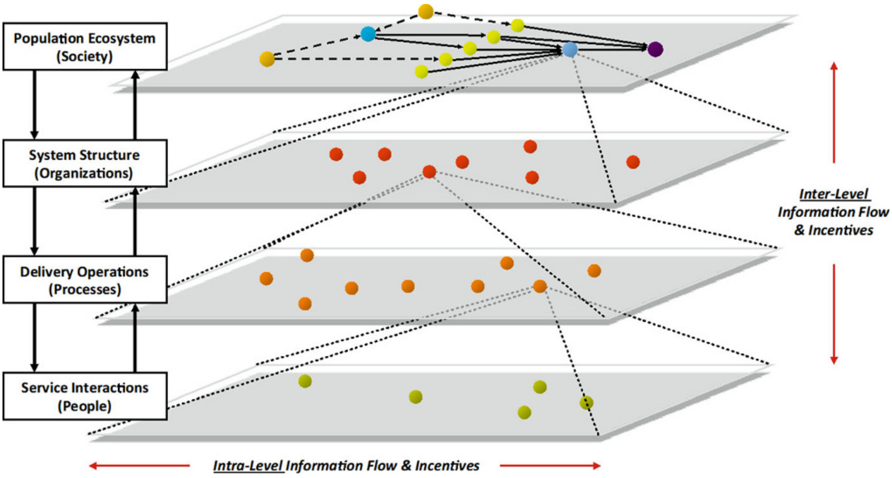


**Fig. 26.4** Multi-level services network model

There is no standard set of models with which to populate Figs. 26.3 and 26.4. Hence, it is helpful to illustrate the use of the framework for particular examples. In this section, we will consider the impact of payment schemes on network operations. Our later case study focuses on population health for substance abuse.

### *26.4.1 Effects of Payment Schemes*

Table 26.1 summarizes how different health payment schemes affect what happens at each level of Figs. 26.3 and 26.4. The key distinctions are between the middle and rightmost columns. The middle column addresses price controlled reimbursement, also termed fee for services, and focuses on procedures, processes for delivering procedures, and reimbursement for procedures. The right column addresses pay for value delivered and emphasizes health outcomes, procedures for delivering health outcomes, and payment for achieving health outcomes.

In an application of this framework for employer-based prevention and wellness, the payer was entertaining payments to the provider for reducing the risks of Type 2 Diabetes (DM) and Coronary Heart Disease (CHD), rather than the costs of the services provided (Park et al. 2012). Not surprisingly, this caused the provider to quickly focus on the extent to which each of their services contributed to reducing DM and CHD risks.

In an education version of this line of reasoning, the City of Chicago has recently announced (Post 2017) that, as of 2020, high school graduation requirements include documentation proving that seniors “have been accepted into college, or the military, or into a trade or gap-year program, or have secured a job.” Students and their families will rightfully demand that high schools support meeting this requirement.

**Table 26.1** Payment schemes versus phenomena

| | Continued price controls (micromanaging processes) | Pay for value (incenting outcomes) |
|---|---|---|
| Society (government and employers) | Budgets, policies and rules defining payers' processes to pay for costs of procedures | Budgets, policies and rules defining payers' processes to pay for health outcomes |
| Organizations (providers and payers) | Decisions regarding procedures and processes designed to maximize reimbursement; implementation of rules | Decisions regarding interventions and processes designed to support and optimize health outcomes; implementation of rules |
| Processes (in-patient and out-patient) | Flows of patients, information and money through deployed procedure-oriented processes | Flows of patients, information and money through deployed outcome-oriented processes |
| People (patients and clinicians) | Clinician choices among available procedures; patient disease progression | Clinician choices among available interventions; patient health outcomes |

This will mean that schools will have to pay attention to services that help achieve this outcome, perhaps by moving resources from other services that less directly contribute to this outcome.

Table 26.3 summarizes possible modeling approaches for each level of Figs. 26.3 and 26.4, for each of the two payment schemes. The modeling approaches are similar with two important distinctions. First, the price controls column focuses on maximizing revenue while the pay for value column emphasizes maximizing profits. In the middle column, the more you do, the more money you make. In the right column, the less you do while also assuring people are healthy, the more money you make.

The second key distinction concerns patients' states. The middle column focuses on disease incidence and progression. The right column adds the notion of health states. In this column, interventions, rather than procedures, are also directed at keeping people healthy. For example, increased investment in K-12 nutrition and physical education would be seen as an investment in population health. The key in the right column is that you make more money if people do not get sick, so it makes sense to invest in this outcome.

Figure 26.5 depicts the flow of variables among the models at each level of Figs. 26.3 and 26.4. This is useful once one gets to the point of programming the set of models, often using commercial tools that provide good support for rapid prototyping. This topic is, obviously, beyond the scope of this chapter.

What particular models, or modeling paradigms, should one employ? As indicated earlier, there is no standard recommendation. Table 26.3 summarizes a range of alternatives. Choices among these alternatives, and various others, are discussed in Rouse (2015).

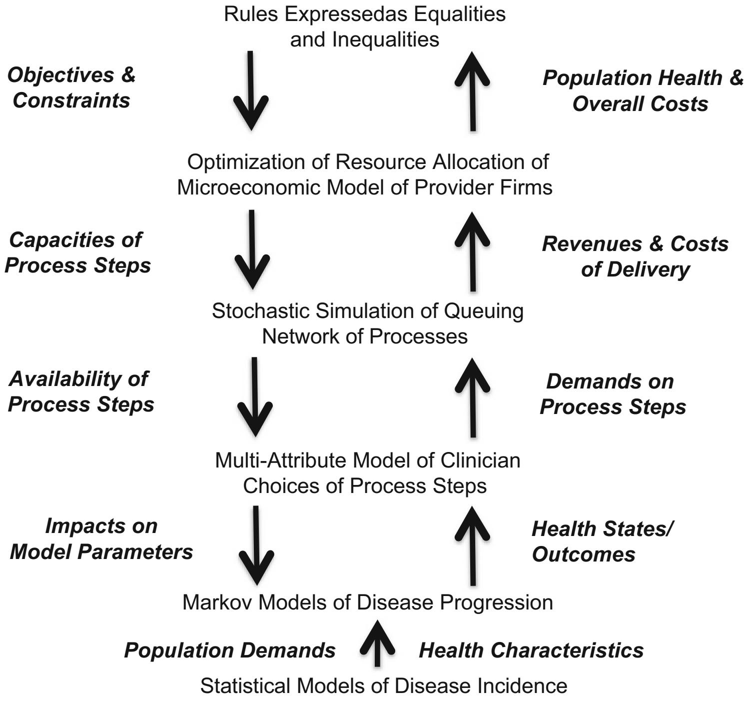


**Fig. 26.5** Flow of variables

## 26.4.2 Discussion

Figs. 26.3, 26.4, and 26.5 and Tables 26.1, 26.2, and 26.3 provide an overall modeling framework. Several particular issues need to be considered in more depth to address the full spectrum of important issues in population health.

At the society and organization levels, we need to consider much richer variations of payment schemes. Bundled payments for population health might help overcome some of effects of fragmentation. Payment for outcomes has some intuitive appeal, but might lead providers to avoid very difficult patients. Of course, the impact and unpredictability of payment schemes are currently pervasive problems across healthcare (Bailey 2017). Great uncertainties can quite reasonably lead to increased risk aversion in decision making.

At the process level, we need to more explicitly address passing the baton and care coordination issues. This requires that we consider the timeliness of information sharing across elements of service supply chains. This, in turn, requires that we incorporate the efficiency and effectiveness of information infrastructure into our models.

**Table 26.2** Payment schemes versus models

| | Continued price controls (micromanaging processes) | Pay for value (incenting outcomes) |
|---|---|---|
| Society (government and employers) | Rule-based model of equalities (=) and inequalities (< or >) constraining budgets and payers' processes for reimbursing costs | Rule-based model of equalities (=) and inequalities (< or >) constraining budgets and payers' processes for incenting outcomes |
| Organizations (providers and payers) | Microeconomic model for resource allocation across process steps (procedures) to maximize revenue within constraints imposed by rules | Microeconomic model for resource allocation across process steps (interventions) to optimize profit vs. health outcomes within constraints imposed by rules |
| Processes (in-patient and out-patient) | Queuing network model of flows through process steps (procedures) with capacities determined by resource allocation | Queuing network model of flows through process steps (interventions) with capacities determined by resource allocation |
| People (patients and clinicians) | Decision theory models of clinicians' choices of procedures; Markov models of patients' disease progression; statistical models of disease incidence | Decision theory models of clinicians' choices of interventions; Markov models of patients' health state and/or disease progression; statistical models of disease incidence |

**Table 26.3** Levels versus alternative models

| Level | Issues | Models |
|---|---|---|
| Society | GDP, supply/demand, policy | Macroeconomic |
| | Economic cycles | System Dynamics |
| | Intra-firm relations, competition | Network Models |
| Organizations | Profit maximization | Microeconomic |
| | Competition | Game Theory |
| | Investment | DCF, Options |
| Processes | Patient, material flow | Discrete-Event Models |
| | Process efficiency | Learning Models |
| | Workflow | Network Models |
| People | Patient behavior | Agent-Based Models |
| | Risk aversion | Utility Models |
| | Disease progression | Markov, Bayes Models |

This can build upon the vision of the Office of the National Coordinator for Health Information Technology (IOM 2015; ONC 2015), although this thinking needs to be extended to education and social services as well. Beyond such institutional endeavors at the organization and process levels, there are people level initiatives that are leading to patients and their families having direct access to information resources and decision support, e.g., Topol (2017) and Torous (2017).

Also at the people level, we need to incorporate a range of behavioral economics approaches to how humans address change, e.g., (Thaler and Sunstein 2008;

Kahneman 2011), including how choices vary across people's life span. Reducing the complexity of the service network, from users' points of view, combined with well-designed behavioral economics nudges are important keys to success. This extension would expand consideration of alternative models of patient choice—utility maximization, prospect theory, and random choice.

Another important consideration is relationships among agents, which have been found to have very significant impacts, e.g., (Fowler 2008). Social network relationships can have both negative effects (increased addiction) and positive effects (increased treatment), e.g., family and friend support structures can make a huge difference. Note that many of the components of population health discussed have social components. Social effects would undoubtedly also affect probabilities of engagement and retention over time.

## 26.5 Case Study: Substance Abuse

Sam Quinones (Quinones 2015) in Dreamland portrays the panorama of the current substance abuse epidemic in America—opioid abuse. Several prominent phenomena underlie this epidemic, including:

- Economics of rust belt—no jobs, SSI dependence, Medicaid $3 co-pay for pills worth $10,000 on the street
- Economics of rural Mexico—landless rural poor scraping out an existence; interestingly, do not use drugs themselves
- Medicine's business model for pain treatment—all types of pain warrant pain pills; over-prescription quite common
- Pharma's business model for pain pills, including misleading advertising; an aggressive sales force model; and incentives for doctors to prescribe opioids
- Insurance companies' finding that paying for opioid pills is cheaper than paying for holistic treatment of pain
- Delusion that opioids are not addictive, based on one paragraph letter to editor in New England Journal of Medicine (Porter and Jick 1980)—of 12,000 patients treated with opiates while in hospital, only four became addicted
- Heroin becoming much cheaper than OxyContin, and being much more potent; heroin being cheaper than treatment for addiction

Our sense is that society knows—medically, psychologically, and socially—how to help those who are addicted (Schuchat et al. 2017). But, our highly fragmented delivery system is not capable of delivering integrated services in timely, affordable, and convenient ways. In a recent issue of Modern Healthcare (Livingston 2017), it is noted that many of the people who cannot afford treatment, e.g., the co-pay is much too high, tend to stay on heroin because it is much cheaper than treatment.

The fragmentation of the US systems for health, education, and social services appears to result in underinvestment in social services, which leads to greater downstream health difficulties and costs (Bradley and Taylor 2013). In this example,

we argue for the immense benefits of greater integration in terms of both better health outcomes and reduced costs.

The consequences of inadequate treatment of substance abuse illnesses are immense. The long waiting times, across the healthcare ecosystem, due to inadequate and poorly organized treatment capacities increase the likelihood of patients delaying or postponing treatment, and a higher rate of missed appointments (Kaplan et al. 2015; Ryu and Lee 2017). Carr et al. (2008), as well as Redko et al. (2006), report on similar impacts of long waiting times. These problems have been with us for a long time. The consequences are, as elaborated later, that many patients are not served.

Walker et al. (2015) report that mental disorders reduce lifespan by 10 years due to higher risk of suicide and reduced abilities to manage chronic diseases. Worldwide, eight million deaths each year are attributable to mental disorders. This compares to a total of 55 million deaths annually, 18 million due to heart disease, nine million due to cancer, and 1.3 million due to road traffic accidents. Clearly, the ultimate consequences of inadequate treatment are immense.

This example proceeds as follows. In the next section we introduce an initial model that helps explain the source of extreme delays in treating substance abuse. The insight provided by this model leads to a discussion of treatment capacity issues, including scheduling practices. Consideration of the full spectrum of services needed to address substance abuse subsequently broadens the scope of the discussion.

This leads to a second model that addresses health service supply chains, typical service problems in population health, phenomena at each level of the enterprise, how these phenomena can be represented, and data for estimating parameters within these representations. The consequences of treatment delays are projected using this model.

A third model is used to consider the impacts of alternative scheduling practices. Coordinated scheduling is projected to both increase patient engagement and yield enormous savings. We conclude with a discussion of the results in terms of savings possible with more prompt treatments and how these resources might be invested in new models of care that would substantially decrease delays and improve health outcomes.

### *26.5.1 Model One: Sources of Delays*

Why are waiting times for treatment so long? A very simple model can help to explain the source of these delays.

Consider a population health system where patients visit N service providers. Patients flow through these providers, branching from provider to provider. Their total time in the system is given by

$$\mathrm{WT} = \mathrm{W1} + \mathrm{W2} + \ldots + \mathrm{WN} \tag{26.1}$$

We could add binary weights to this equation to represent the possibility that a patient does not visit every provider.

The time required to be serviced by each provider, Wi, has three components:

- Time from request of appointment for service until actual appointment, WA
- Time waiting in the service queue to be serviced, WQ
- Time being serviced, W-WQ, where W is the total time at the provider's facility

We can model this system as an M/M/S queuing system, where the first M designates Poisson distributed interarrival times, the second M designates exponentially distributed service times, and S denotes the number of servers, or the capacity of the service provider (White et al. 2012).

This rather standard queuing model can be solved to yield several performance metrics:

LQ = Expected number of patients waiting.

L = Expected number of patients in the system.

WQ = Expected time spent waiting.

W = Expected total time, including service.

### *26.5.2 An Example*

Assume that a service provider averages 30 patients per day and each server, e.g., a psychiatrist, can serve ten patients per day. Given random variations of arrivals and service times, the provider will need more than three servers. Table 26.4 shows the impact of having 4, 5, or 6 servers. Converting WQ from days to minutes, we get 24, 6, and 2 min for 4, 5, or 6 servers, respectively.

WQ and W are provided in Table 26.1, but what about WA? WA can increase due to concerns about WQ. Most providers are keenly aware of the time people spend in the waiting room. Let's assume, they constrain WQ to 15 min. This means that they need five servers, who can see 50 patients per day, i.e., five servers times ten patients per server. If demand for services exceeds this level, then patients have to be scheduled for future days. If 5000 patients want the service for which the provider

**Table 26.4** Performance of M/M/S System for S = 4, 5, or 6

| | Number of servers | | |
|---|---|---|---|
| Performance measures (days) | 4 | 5 | 6 |
| Utilization | 0.750 | 0.600 | 0.500 |
| P(0), probability that the system is empty | 0.038 | 0.047 | 0.049 |
| LQ, expected number in queue | 1.528 | 0.354 | 0.099 |
| L, expected number in system | 4.528 | 3.354 | 3.099 |
| WQ, expected time in queue | 0.051 | 0.012 | 0.003 |
| W, expected total time in system | 0.151 | 0.112 | 0.103 |
| Probability that customer waits | 0.509 | 0.236 | 0.099 |

only has capacity for 50 per day, patients will be scheduled 100 days in advance. Thus, demand is being managed by stretching it out in time.

This initial model is, admittedly, very simple. Its usefulness is to show how concerns about WQ have pervasive impacts on WA. We next need to explore the capacity issues that underlie these impacts.

### *26.5.3 Capacity Issues*

WA is the important component for substance abuse and reflects current demand management practices. Within-hospital demand management has been the subject of much research, including the overall construct of patient flow (Hall 2013), as well as approaches to coordinating in-hospital services using agent-based modeling (Decker and Lesser 1995; Decker and Li 2004), combining appointments for in-hospital services via network analysis (Vermeulen et al. 2008), and social network analysis of clinic use (Ben-Ari 2015).

We are concerned with scheduling practices that affect WA. The difficulties in this area are well known (Brandenburg et al. 2015; Ryu and Lee 2017). A central issue is matching capacities to demands. Demands for substance abuse treatment have been increasing much faster than capacities. Johnson (2016) notes that delays in receiving mental health care can easily exceed a year. Special clinics have been opened but there is huge shortage of trained personnel to staff these clinics. While the Affordable Care Act mandated coverage for mental health and substance abuse treatment, Johnson reports on "how unprepared the healthcare system is for meeting the increased demand." He relates estimates from the National Alliance on Mental Illness that "only 41% of adults with a mental illness received treatment over the past year, with around 63% of those with serious mental illnesses getting services over the same period."

HHS (2016) has projected needs for nine specialties that relate to opioid abuse including psychiatrists; behavioral health nurse practitioners; behavioral health physician assistants; clinical, counseling, and school psychologists; substance abuse and behavioral disorder counselors; mental health and substance abuse social workers; mental health counselors; school counselors; and marriage and family therapists. They project that by 2025 most of these specialties will have shortages exceeding 10,000 full-time equivalents.

### *26.5.4 Scheduling Practices*

The waiting times for the full spectrum of services needed for substance abuse treatment can be months or longer because:

- Patients do not know which service they will need next until they get the results of the current service
- Patients often need a referral from the provider of the current service for the payer to approve the next service
- Services that are not highly reimbursed have longer waits, in the US at least, e.g., mental health services (Dickson 2015), as well as the old and frail with chronic diseases
- Waiting times are increased by the combination of prioritization of highly reimbursed patients and under-investment in capacities for poorly reimbursed services (Ryu and Lee 2017)

Therefore, the scheduling problems are immense, with the dire consequences outlined earlier. Unfortunately, the problem is even more complicated than thus far portrayed.

### *26.5.5 Services Needed*

Table 26.5 describes the spectrum of services needed, drawing upon Sussman et al. (2011). They outline 14 components of addiction within four categories—pragmatics, attraction, communication, and expectation. In this table, we suggest how these 14 components should be addressed.

This enables a much broader specification of the services needed to address substance abuse, as well as a much richer sense of the population health service supply chain. Figure 26.2, introduced earlier, portrays who is involved in providing these services. Clearly, the fragmentation of the delivery system is an enormous problem. Substance abuse patients are completely unprepared to deal with the system portrayed in Fig. 26.2. The findings reported by Walker et al. (2015) fully support this assertion.

**Table 26.5** Spectrum of services needed to address substance abuse

| Component | Intervention/service | Comments |
|---|---|---|
| Supply | Limit or legalize | Discourage drug organizations |
| Awareness | Educate regarding risks | K-12, clubs, sports, churches |
| Acquisition | Limit or legalize | Discourage drug organizations |
| Means | Force prices higher or make free | Cheaper alternatives sought |
| Defiance | Address psych, social, econ causes | Proactive social services |
| Pleasure | Distract with other activities | Socials, clubs, sports, churches |
| Differences | Understand each individual | Personalized health |
| Language | Educate regarding risks | K-12, clubs, sports, churches |
| Skills | Legalize, make free | Discourage drug organizations |
| Identification | Distract with other affiliations | Clubs, sports, churches |
| Consequences | Educate regarding risks | K-12, clubs, sports, churches |
| Disposition | Address psych, social, econ causes | Proactive social services |
| Motivation | Address psych, social, econ causes | Proactive social services |
| Image | Educate regarding risks | K-12, clubs, sports, churches |

### 26.5.6 Model Two: Impacts of Delays

Our approach to addressing the complexity of Fig. 26.2 draws upon macro and microeconomics, service supply chain management, and behavioral economics. As noted earlier, managing supply chains of services poses different problems than flows of component parts to OEMs or foodstuffs to grocery shelves.

The expansion of our initial model employs Fig. 26.3, discussed earlier, to examine the relevant phenomena at each level of the enterprise. The extended model outlined here is intentionally limited to predicting expected values of key variables. Later versions will add simulation capabilities to enable exploration of the impacts of variability.

At the people level, central phenomena include establishing a route through the many services in Table 26.5 in terms of the length of the route. People may balk (not become patients) or renege (drop out of treatment) along the route, characterized by probabilities PB and PR versus delay time. Health consequences of delayed treatment include death with probability PD versus cumulative delay.

Process level phenomena include getting appointments for each service in the route. Delays between services can be characterized in weeks. Delays, as shown by the initial model, are due to capacity constraints.

At the organization level, capacity constraints are due to investment policies, as well as availability of personnel. On the level of society, investment policies are related to payer reimbursement policies for different Diagnostic Related Groups.

"Passing the baton" and "service coordination" issues are represented in terms of delays. We do not yet consider, at least not explicitly, the information systems required for smoothly passing the baton and coordinating services.

### 26.5.7 Representing Phenomena

Treatment is represented as a series on N steps with time period of TA between them. Thus, completing treatment requires

$$T = (N - 1)TA \tag{26.2}$$

Patients can balk (not enter treatment) or renege (not complete treatment). The probabilities of these phenomena are given by typical S-curves or logistic functions.

$$PB = P_{B0}/\{1 + \exp\left[-k_B(T - t_{B0})\right]\} \tag{26.3}$$

$$PR = P_{R0}/\{1 + \exp\left[-k_R(T - t_{R0})\right]\} \tag{26.4}$$

The probabilities of completing treatment (PC) and not completing treatment (PN) are given by

$$\mathrm{PC} = (1 - \mathrm{PB})(1 - \mathrm{PR}) \tag{26.5}$$

$$\mathrm{PN} = \mathrm{PB} + \mathrm{PR}(1 - \mathrm{PB}) \tag{26.6}$$

The expected cost per patient is thus

$$\mathrm{CP} = \mathrm{PC}\ \mathrm{CT} + \mathrm{PN}\ \mathrm{CN} \tag{26.7}$$

where CT and CN are the costs of treatment and non-treatment, respectively. Multiplying by the total number of potential patients yields the total costs of addressing the population.

### *26.5.8 Data for Parameters*

Model parameters are based on a variety of sources. There are well over 20 million people in the US needing treatment. Roughly 10% receive treatment. Of those who do not receive treatment, more than 95% did not think they need treatment, perhaps due, in part, to the stigma associated with substance abuse (Olsen and Sharfstein 2014). Roughly 50% drop out of treatment (NIH 2011; Lipari et al. 2016).

Delays from initial diagnosis to treatment average more than a decade (Wang et al. 2004). Lower levels of employment, educational attainment, and income are positively correlated with mental illness and the lack of health insurance coverage (McLaughlin 2004). Lack of insurance affects whether or not treatment is sought.

Substance abuse treatment costs $1583 per patient and saves $11,487 (Ettner et al. 2006). Thus, not being treated results in substantially higher costs of healthcare as well as criminal activities, i.e., courts and incarceration. Another study found that medical and hospitalization costs were $359 lower per month for those in treatment, compared to those not in treatment (Estee and Norlund 2003). We use the former data for the model results discussed below.

Finally, as noted earlier, mental disorders reduce lifespan by 10 years due to higher risk of suicide and reduced abilities to manage chronic diseases (Walker et al. 2015). Substance abuse deaths have increased 10% annually over the period 1999–2015 (NIH 2017). Specifically, there were 33,000 deaths in 1999 and 150,000 in 2015, for both legal and illegal drugs.

### *26.5.9 Results*

The above data were used to parameterize Eqs. (26.2) through (26.7). For example, we used these data to set $P_{B0}$ to 0.95 and $P_{R0}$ to 0.50. The rate parameters $k_B$ and $k_R$ were both set to 0.05. The inflection parameters, $t_{B0}$ and $t_{R0}$, were set to 20 and 40, respectively. The resulting probability curves are shown in Fig. 26.6.

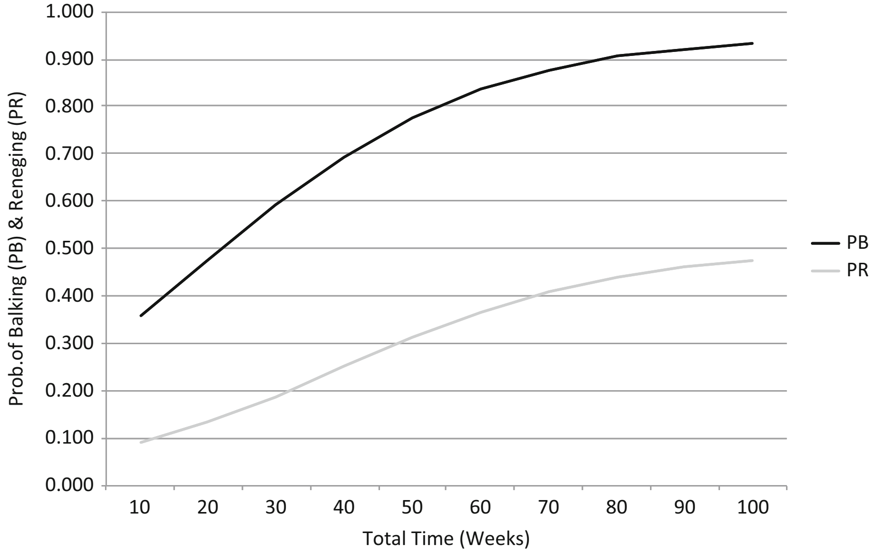


**Fig. 26.6** Probabilities of balking and reneging

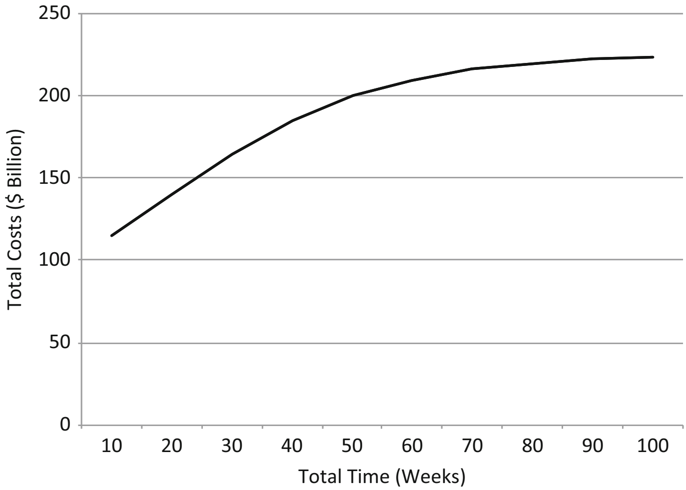


**Fig. 26.7** Total annual costs ($billion) as a function of time delays

We varied N and TA, and hence T, to obtain the results in Fig. 26.7. Note that the probability of completing treatment, PC, equals 0.583 for 10-week delays and 0.035 for 100-week delays.

We could not find sufficient data to define a relationship between probability of death and time delays. However, the data noted above indicates that deaths are

rapidly escalating and, on average, occur ten years earlier than for those not afflicted with substance abuse.

The median US income was roughly \$58,000 in September 2016 as reported by the Census Bureau. Federal income taxes, State income taxes, Social Security taxes, and Medicare taxes totaled over 25% or roughly \$15,000. So, dying ten years early deprives government coffers of roughly \$150,000 per person. At an extreme, the 150,000 deaths in 2015, deprived the government of 150,000 deaths times \$150,000 taxes over 10 years which equals \$22.5 billion over ten years or \$2.25 billion per year.

The total loss of economic contribution to society, i.e., total income not just taxes paid, is roughly four times larger, i.e., \$90 billion. The numbers would be much higher were we to consider the loss of productivity while still alive due to substance abuse (EOP 2012). The key point is that keeping people healthy does not just avoid costs. Healthy people generate economic value for society as well as government coffers.

### 26.5.10 Model Three: Reducing Delays

More efficient scheduling can reduce delays. The third model will enable a simple comparison of two types of scheduling:

- Contingent: The next service is scheduled upon departure from the last service. Thus, only one service is scheduled at a time.
- Coordinated: Every one of N services is scheduled in advance and the sequence is determined to minimize overall times to receive all services, taking into account precedence relationships, e.g., need to see a primary care physician to obtain a referral to a psychiatrist.

To compare these two approaches to scheduling, Eq. (26.1) is expanded to

$$\mathrm{WT} = (\mathrm{WA1} + \mathrm{W1}) + (\mathrm{WA2} + \mathrm{W2}) + \ldots + (\mathrm{WAN} + \mathrm{WN}). \tag{26.8}$$

This explicitly separates appointment time from time in service.

To illustrate the fundamental difference between the two approaches to scheduling, assume WAi and Wi are the same for all services, denoted by WA and W. Thus, the patient waits WA for the first service and then experiences W for this service. Knowing this, the coordinated approach schedules the second service for WA + W. The patient waits zero time for the next service and then experiences W for this service, and so on.

For all N services, the patient spends total time of

$$\mathrm{WT} = \mathrm{WA} + \mathrm{N\,W} = \mathrm{N}(\mathrm{WA}/\mathrm{N} + \mathrm{W}) \tag{26.9}$$

For the contingent scheduling, the patient would spend total time of

$$WT = N(WA + W) \tag{26.10}$$

The ratio of scheduled to contingent service is

$$R = (WA/N + W)/(WA + W) \tag{26.11}$$

For WA $\gg$ W, which is typically the case, R approaches 1/N.

Assuming there are ten services, we can reduce overall time by as much as 90%. From Fig. 26.7, the difference between 10 weeks delay and 100 weeks delay amounts to $108 billion annually due to 58% receiving treatment versus 3.5%.

Therefore, we should be willing to invest up to that amount to reduce 100 weeks of delay to 10 weeks. Note that coordinated scheduling does not increase the costs of service delivery. Thus, the $108 billion could be used to improve patient experiences and nudge them to engage and stay engaged.

If we add in the lost economic contribution due to premature deaths, we could invest roughly $200 billion. Accounting for lost productivity would allow further investment. Considering total costs, the National Institutes of Health (NIH 2016) reports that substance abuse, which includes tobacco, alcohol, illicit drugs, and prescription opioids, costs the US $740 billion annually in terms of crime, lost work productivity, and healthcare. $232 billion (31%) is for healthcare.

### *26.5.11 Models of Care*

Summarizing the essence of the problem, SAMHSA (2017), reporting data from 2014, indicates that 21.2 million Americans ages 12 and older needed treatment for an illegal drug or alcohol use problem in 2014. However, only about 2.5 million people received the specialized treatment they needed in the previous 12 months. They indicate that, "Back and forth referrals between behavioral health and primary care services result in up to 80% of individuals not receiving care."

SAMHSA (2013) summarizes the seriousness of not receiving care, "Research has indicated that persons with substance abuse disorders have 9 times greater risk of congestive heart failure, 12 times greater risk of liver cirrhosis, and 12 times greater risk of developing pneumonia." Despite such comorbidities, they report that, "54% of addiction treatment programs have no physician."

How should monies be redirected to address this problem? The status quo is for patients to access independent services provided across the fragmented delivery system. A system where behavioral health and primary care are integrated would inevitably reduce delays. A fully integrated, comprehensive treatment program would include the proper array of clinicians (doctors, nurses, psychologists, social workers, etc.) accessible in one location.

Having to get pre-approval from the insurer might continue to be a problem. Perhaps that could be obviated by approval once for the total therapeutic program up

front. This will not overcome all ability to pay issues. Another issue is whether there are enough drug treatment centers and whether they are conveniently located. The problem is particularly important in rural areas. Where will patients in such areas get help? Given these caveats, we need to address the effectiveness of this treatment model.

### *26.5.12 Effectiveness of Treatment*

Is an integrated approach to treatment effective? Several studies have addressed this question, with promising results but rarely definitive evidence. Sisk et al. (1990) discuss Therapeutic Communities (TCs) that aim at a complete behavior change and a drug-free lifestyle. Two large studies reported 90–95% of program graduates were abstinent from opiates and not involved in criminal activity two years later. Nevertheless, both residential TCs and outpatient drug free programs have significant retention problems as well as relapse problems.

Drake et al. (1998) review 36 studies of integrated versus independent treatment of multiple disorders. Results of 26 studies that involved adding one specialty were disappointing. Results of ten studies of fully integrated outpatient programs were encouraging in helping to reduce substance abuse and attain remission. Brunette et al. (2004) review ten studies of residential programs—most of them conducted after Drake et al. (1998) was published. Results "suggest" benefits, but there were a variety of methodological flaws. Weisner et al. (2001) report that integrated care led to higher abstinence for those with substance abuse-related medical conditions—69% versus 55% for those with independent (non-integrated) care.

McVay et al. (2004) contrast the costs of treatment with the costs of incarceration. They report quite substantial cost savings and significantly better health outcomes. Their findings include:

- Treatment can be much less expensive than a term of imprisonment.
- Treatment can be cost effective, much more so for treatment outside of prison yards.
- Treatment can reduce substance abuse and recidivism. Clients are much less likely to be arrested and much more likely to be employed.

Promising treatment models exist around the country, several of which they summarize.

Meara and Frank (2005) address effectiveness by noting that, "Substance abuse has high social costs, yet few people receive the many effective treatments available, partly because of financial barriers to treatment." They review many studies; particularly those related to integrated treatment that combines medication with cognitive behavioral theory. While the reported impacts are positive, they conclude that we simply do not have enough data to determine the optimal level of expenditures on treating substance abuse.

Wahlbeck (2010) observes that limited data on the effectiveness of integrated treatment systems is positive, but far from definitive. He argues that greater integration of social services is central. The National Institutes of Health (NIH 2012) indicates that, "Most people who get into and remain in treatment stop using drugs, reduce their criminal activity, and improve their occupational, social, and psychological functioning." Relapse rates are similar to those for diabetes, hypertension, and asthma, which also have physiological and behavioral components.

The National Treatment Agency in the UK (NTA 2012) indicates that residential rehab accounts for 2% of the people in adult drug treatment but 10% of the cost, about $780 per person per week. For every ten people who go to rehab, three overcome their addiction, one drops out, and six go on to structured community support. Of these six, two overcome their addiction, at least two are still in support, and at least one drops out. The best rehabs see over 60% of patients succeed; the worst struggle to achieve 20%. The best performers do well with complex patients. Rehabs are more successful addressing alcohol abuse, "possibly because dependent drinkers have more personal and social capital to invest in recovery." They are considering moving to pay for performance.

### *26.5.13 Features of Treatment*

Several researchers isolated what aspects of treatment were most important. Drake et al. (1998) summarize program features that were associated with effectiveness including assertive outreach, case management, and a longitudinal, stage-wise, motivational approach.

Coviello et al. (2013) report that offenders whose treatment was court-ordered were over ten times more likely to complete treatment compared to those who entered treatment voluntarily. DuPont (2014) discusses metrics for success from the perspectives of patients, providers, and payers and summarizes metrics for each type of addiction.

Brunette et al. (2004) note that many types of patients do not do well in outpatient programs. They need stable, safe, and supportive living arrangements; peer support for recovery; external controls to compensate for limited internal controls; and easy access to services and continuity of connection to treatment. Residential programs provide all these services in one convenient package.

### *26.5.14 Design Principles*

Marlatt et al. (2001) propose eight design principles for integrated treatment programs:

1. "Deliver care in a culturally competent and non-judgmental manner which demonstrates respect for individual dignity, personal strength, and self-determination
2. Service providers are responsible to the wider community for delivering interventions that will reduce the economic, social, and physical consequences of substance abuse and misuse
3. Providers must seek creative opportunities and develop new strategies to engage, motivate, and intervene with potential clients
4. The goal is to decrease the short-term and long-term adverse consequences of substance abuse, even for those who continue to use drugs
5. Treatments must include strategies that reduce harm for those clients who are unable or unwilling to stop using, and for their loved ones
6. Relapses or periods of return to use should not be equated with or conceptualized as failures of treatment
7. Patients prescribed medications for the treatment of medical and psychiatric conditions, including addition, must have full access to substance abuse treatment services
8. Each program within a system of comprehensive services will be stronger by working collaboratively with other programs in the system."

SAMHSA (2013) reviews efforts to develop integrated treatment models. They outline capabilities needed for integrated treatment and propose a six level framework.

1. Minimal collaboration
2. Basic collaboration at a distance
3. Basic collaboration onsite
4. Close collaboration onsite with some system integration
5. Close collaboration approaching an integrated practice
6. Full collaboration in transformed/merged integrated practice

A wide range of existing examples at each level is discussed, including success factors and lessons learned. This report also considers the hurdles and difficulties of financing integrated treatment.

### *26.5.15 Summary*

Integrated treatment of substance abuse disorders is very promising, but a work in progress. We need to better understand the behavioral economics of substance abuse. How can we best engage and retain patients? This example has emphasized the negative impacts of inordinate delays in treatment. This is very important, but we need to better understand engagement and retention, as well as the cost effectiveness of integrated treatment.

Fortunately, technology trends portend help with engagement and retention. Artificially intelligent support systems, e.g., web-based apps and cyber-social networks, are likely to enable patients and their families to experience integrated care despite the inherent fragmentation of the ecosystem. The result will be augmented intelligence for all the people in the ecosystem. Everyone will feel much more empowered and collaborative care will become the norm.

## 26.6 Conclusions

This chapter has focused on how population health can be conceptualized and managed as a large multi-level network of services. Specifically, how can we deliver the health, education, and social services to keep a representative population healthy within the highly fragmented US delivery system? A central consideration was the coordination of care, ranging from prevention and wellness, to chronic disease management, to acute care and managing the transition of patients from hospital to home, as well as from home to follow up visits and social services. This chapter provided a model-based framework for addressing the issues and possible solutions to successfully managing this whole process. This framework was illustrated by considering the differing impacts of alternative payment schemes. A case study focused on treatment of substance abuse.

A variety of research issues were raised. How can we best employ systems science, behavioral economics, social networks, and artificial intelligence to foster the health system that we want, to a great extent by morphing the health system that we have? There is ample room for many research initiatives, particularly those that transcend traditional disciplinary boundaries. Population health is far from a one discipline problem.

We hope that the type of thinking presented in this chapter can inform the very important task of transforming and integrating the delivery of population health in the US. This transformation will be very difficult and create many challenges and risks for a wide range of stakeholders. Our experience is that model-based approaches can span the many boundaries that need to be crossed in times of change. We hope that the type of thinking presented in this chapter can inform the very important task of transforming and integrating the delivery of population health in the US.

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# Chapter 27
# Incremental and Radical Service Innovation in Healthcare

**Peter Samuelsson, Lars Witell, Patrik Gottfridsson, and Mattias Elg**

**Abstract** The growing cost and demand of healthcare is a major concern globally. Service innovation has been put forward as a top priority to address the challenges of healthcare. However, the concept of service innovation is poorly understood, in particular the differences between incremental and radical service innovation. The chapter makes two important contributions. Firstly, it conceptualizes incremental and radical service innovation based on internal and external changes; in particular, it identifies four types of service innovations. Secondly, it explores the effects and diffusion processes of service innovation. It aids practitioners and researchers to understand radical service innovation in a new way and to shed light on effects and diffusion of service innovation in healthcare.

**Keywords** Service innovation · Healthcare · Public sector · Wellbeing

## 27.1 Introduction

In the last decades, governments and citizens have seen an increase in cost and demand for healthcare. In the United States, spending on healthcare reached US$3.2 trillion in 2015; as a percentage of the country's GDP (17.8%), this was higher than

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_27

any other nation (World Health Organization 2016). The growth in both cost and demand can be traced back to progress in medical treatments and an aging population; we are simply living longer, due to improvements in healthcare and society overall. However, the dramatic rise in healthcare expenditures in the US over several decades has not been followed by dramatic improvements in healthcare outcomes, particularly when compared with other developed countries (Joiner and Lusch 2016).

To face this situation, innovation has become a top priority, with the aim of increasing the efficiency and effectiveness of healthcare using new and improved medical treatments, structures, and processes. The focus has expanded from a narrow focus on medical and technological innovation to also include service innovation. Service innovation is an ill-defined term that has different meanings in different research fields and schools of thought (Snyder et al. 2016). For a long time, innovation was regarded as a technological breakthrough that created profits for the provider, without accounting for the concept of value creation (Witell et al. 2016). However, changing the process of value creation is a core part of the present view of service innovation (Ostrom et al. 2010; Gustafsson et al. 2016), where change is the institutionalization of new or altered resource integration practices (Koskela-Huotari et al. 2016). Based on an increased emphasis on value creation there is a need to re-visit and create a new understanding of service innovation in healthcare.

The distinction between incremental and radical innovation is one of the most frequently used categorizations in service research (Snyder et al. 2016). Previous research has shown that service innovations most often are incremental (Gustafsson et al. 2016) and that cumulative small changes can make a huge difference (Bolton et al. 2014). However, what is really a radical service innovation? Is it radical when an innovation is completely different from the existing solution, or when it has a huge impact on the health of individuals? Existing distinctions between incremental and radical service innovation provide limited insights in how to manage service innovations, both regarding development and diffusion processes.

Innovation in the public sector in general and healthcare in particular poses specific challenges to the service innovation concept since it does not have a clearly defined beneficiary; and there are many actors involved. The specific challenges of healthcare provide a unique opportunity to further develop the service innovation concept. Djellal et al. (2013) revealed resource scarcity (Witell et al. 2017) for service innovation in the public sector, emphasizing that an organization’s most valuable resources are different actors in its network (Håkansson and Snehota 2006). It is highly relevant to look into diffusion of service innovation as embedded in value constellations in the public sector. And perhaps there are no other context where effect is more vital, both in terms of cost savings and in the savings of life.

The purpose of this chapter is: (1) to further develop the service innovation concept including incremental and radical service innovation in the context of healthcare; and (2) to explore the implications of incremental and radical service innovation for diffusion and improvements of the healthcare system. The chapter is conceptual and will through a literature review on service innovation in healthcare

and radical service innovation challenge existing conceptualizations of service innovation. The chapter will use empirical illustrations from Swedish healthcare to highlight what service innovation is in practice.

## 27.2 Service Innovation in Healthcare

Healthcare services is a prerequisite for society to flourish, but there is also immense political and financial pressure to provide better and faster healthcare using less resources. Although there is a need for standardization through evidence-based clinical guidelines, healthcare services often need customization to fit not only a healthcare customer's medical condition but also the customer's age, mental condition, personal traits, and the extended network such as family and friends (Joiner and Lusch 2016; McColl-Kennedy et al. 2017). On a general level, healthcare services are similar to traditional services in that they are intangible, perishable, and require knowledge and skills from the service provider and sometimes also the healthcare customer. However, healthcare also has some distinguishing characteristics; for example, customers are sick, often reluctant and there is a need to share personal and often very private information (Berry and Bendapudi 2007).

Innovation in healthcare has been defined as "a new way of helping medical professionals work smarter, faster, better, and more cost effectively while providing high-quality care" (Thakur et al. 2012). In a similar way, Miller and French (2016) viewed innovation as transformations in service delivery and system design, to improve coordination, quality, and efficiency. As seen in Table 27.1, much of the literature on service innovation is focused on medical innovations, technological innovations, and the role of information technology (IT) in supporting process innovations (Tarafdar and Gordon 2007). However, Djellal and Gallouj (2005) claimed that innovation can occur in all aspects of hospitals' operations and suggested that hospital innovation is highly diverse, encompassing administrative, organizational, and medical practices that are bundled together in services. Windrum and Garcia-Goni (2008) further emphasized that there are different types of service innovations. They operationalized innovations in terms of organizational, market, input, product, and process innovation.

This is consistent with Schumpeter (1934), who proposes several different innovation forms: introduction of a new good, introduction of a new production means, and the discovery of a new source of raw materials, new markets, or new organizations. Snyder et al. (2016) provides an overview of different categorizations of service innovation. Categorizations are helpful since each category contains a number of objects that are considered equivalent and can guide how different categories relate to each other (Rosch et al. 1976).

The mix of public and private healthcare organizations shows that innovation processes are embedded in organizations and institutions that can hamper or encourage innovation (Windrum and Garcia-Goni 2008). Radical service innovations alter the relative power of different actors, such as healthcare customers, physicians, and

**Table 27.1** Research on service innovation healthcare

| Authors | Type of research | Aim | Contributions |
|---|---|---|---|
| Djellal and Gallouj (2005) | Conceptual | To develop a general analytical framework that makes it possible to understand innovation in hospitals | A tool for analysis of hospital output that makes it possible to capture multiple forms of innovation |
| Windrum and Garcia-Goni (2008) | Conceptual | To extend previous work of service innovation with a framework capable of a complex multi-agent environment | Provides an improved definition of incremental and radical innovation |
| Cepeda-Carrion et al. (2012) | Empirical | To study the unique context of hospitals-in-homes-units' ability to challenge basic beliefs. | A model for overcoming the gap between potential and realized absorptive capacity |
| Thakur et al. (2012) | Empirical | To identify the innovative processes used in healthcare management | Provide explanations and examinations regarding developments of innovative ideas |
| Cegarra Navarro et al. (2013) | Empirical, survey | To investigate the extent to which new web-based service delivery channels facilitate eListening in healthcare | Groupware and collective systems to be able to use and benefit from eListening applications |
| Leal-Rodríguez et al. (2013) | Conceptual | To develop a model that examines the link between knowledge innovation and innovation outcomes | A framework of the knowledge base, relational learning, and innovation outcomes |
| Meroño-Cerdan and López-Nicolas (2013) | Empirical, survey | To predict the adoption of organizational innovation within healthcare | There is a close relationship between organizational and product/process innovations |
| Fuglsang and Rønning (2015) | Conceptual | To describe sectorial variance of innovation patterns and their intertwining in public services | The paper points out how varied values guide innovation in public services |
| Chandler and Chen (2016) | Empirical, interviews and netnography | To examine how different practice styles influence service systems | Shows how service systems can change based upon a practice approach |
| Kukk et al. (2016) | Empirical, case study | To gain insights of how institutional change evolves in a technological innovation system | An understanding of actor strategies involved in system building in a technological innovation system |
| Miller and French (2016) | Empirical, case study | To explore the intersection of policy logics and how organizational efforts go about hybridizing them | The paper illustrates organizational efforts to hybridize healthcare and innovational logics |
| Thune and Mina (2016) | Conceptual, literature review | To improve the understanding of the role of hospitals in the generation of innovations | A framework to analyze the functions performed by hospitals in the health innovation system and at different stages of innovation trajectories |

politicians. The different actors, who often have different agendas, make the context of healthcare complex and hence suitable to inform and challenge the traditional concepts of incremental and radical service innovation (Voss et al. 2016). In sum, much of the research on service innovation has focused on technological and medical innovations. Although work practices and changes in processes are also viewed as service innovations in healthcare, they have not been studied to the same extent and have not been used to further develop the conceptualization of service innovation.

### 27.2.1 An Illustration of Service Innovation in Healthcare

Based on a survey of Swedish healthcare, Statistics Sweden investigated hospitals and primary care units in Sweden. The sample contains a mixture of both public and privately founded hospitals and primary care units. The response rate was about half of the hospitals (n = 46) and one-third of primary care units (n = 286). The survey used the Oslo Manual for defining service innovation: "*An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, work place organization or external relations.*" The Oslo Manual includes four different types of innovations, (1) products (goods or services), (2) processes, (3) marketing, and (4) organizational innovations.

In general, there are many service innovation activities in the Swedish healthcare sector. In fact, every healthcare unit introduced at least one service innovation during the last year. However, when asked about radical service innovations, defined as major impact on the operations, only about half of the hospitals and only a third of the primary care units had introduced a radical service innovation. The most common reasons for introducing a radical service innovation were improvements in care quality and to create more value for healthcare customers. In addition, radical service innovation took place to replace an old service or good. The source of origin of radical service innovations were internal sources, most often such innovations were introduced by top-level management.

In the study, hospitals and primary care units were asked to describe one or more radical service innovations they had introduced; see Table 27.2. The most common radical service innovations were (1) internal production improvements or (2) implementation of management models, such as Lean or Balanced Scorecards. Especially, management models such as Lean do not in themselves create large effects, but they do lead to the creation of cumulative incremental improvements. Other examples concerned investments in medical equipment or technology that has enabled new treatments or treatment plans that improves the healthcare customer's journey through the healthcare system. One example of a service innovation is that healthcare customers have gained access to their own medical data and journals through a new Internet platform, which has had a major impact on the care provided by the healthcare unit. From a management perspective, this is not viewed as a

**Table 27.2** Recent service innovations in Swedish healthcare (self-reported)

| Radical service innovations in Swedish Hospitals |
|---|
| A process for discharging patients with the collaborations of caring neighbors |
| New production planning that use available resources more efficiently |
| A new model for provision of medicine |
| The implementation of a new management system with scorecards |
| The implementation of lean manufacturing |
| A management system that connects social services with healthcare |
| A new model of care for senior patients with multiple diagnosis |
| The development of new and improved old mobility aids |
| The implementation of a mobile solution for testing drugs |
| Implementation of production planning and management system |
| A new kidney stone crushing machine, enabling shock wave treatments |
| The implementation of Lean management |
| The implementation of a central reception, where all patients are welcomed |
| The fusion of a hospital and primary care units to provide "borderless care" |
| The development of patient processes in multi-professional teams |
| The development of rapid recovery processes in plastic surgery for knees |
| The re-structuring of hospital management |
| The access to "my journal" online, where medical records are made available |
| A change in medical treatment, to make invasive surgery non-life-threatening |
| Daily-management, where the heads of each department meet every day |
| A new transportation stretcher for small children in ambulances |
| A vacuum suction system from the emergency to the lab, to transport blood |

radical service innovation; from a healthcare customer perspective, however, this is a major change in the healthcare customer experience.

### *27.2.2 A Service Perspective on Radical vs. Incremental Service Innovation*

Even though the existence of radical service innovations has been the questioned (Sundbo 1997), the distinction between incremental and radical is the one most frequently used categorizations of service innovation (Snyder et al. 2016). This section includes a review of existing service research on incremental and radical service innovation, see Table 27.3.

The most used conceptualization is the Lancasterian view of service innovation, which suggests that a service has a number of service characteristics (Gallouj and Weinstein 1997). According to this view, the difference between incremental and radical service innovation depends on the degree to which the service characteristics of the new offering differ from previous offerings. A radical service innovation shares no service characteristics with the previous offering, while incremental service innovation is based on changes to existing service characteristics or the addition of limited new service characteristics without any major changes to the

**Table 27.3** A selection of studies on radical service innovation in service research

| Author(s) | Context | Definition of radical service innovation |
|---|---|---|
| Gallouj and Weinstein (1997) | N/A | Radical innovation' denotes the creation of a totally new product, i.e., one defined in terms of characteristics unconnected with those of an old product |
| Sundbo (1997) | Danish service firms | Innovation in which one radical act creates a large, sudden change in turnover or profit |
| Chan et al. (1998) | Service firms in Hong Kong | Breakthrough service innovations represent significant improvements based on new technologies or approaches which require substantial adjustments in both delivery systems and customer behaviors |
| Oke (2007) | Service firms | Radical innovation is conceptualized along the level of newness, where radical innovation is new to the world |
| Möller et al. (2008) | Empirical illustrations | Radical service innovations are conceptualized as a strategy for completely novel service offerings, to produce new technologies, offerings, or business concepts |
| MartÍnez-Ros and Orfila-Sintes (2009) | Hotels in the Balearic Islands | A clear break with existing practices or technologies and ones that are more likely to incorporate new knowledge and are being introduced to the firm for the first time |
| Cheng and Krumwiede (2011) | Service firms in Taiwan | Fundamental changes in new services that represent revolutionary changes in technology or service benefits |
| Ordanini and Parasuraman (2011) | Luxury hotels in Italy | The extent to which a firm's new services differ drastically from current offerings and require major changes in the application of competences |
| Perks et al. (2012) | A car insurance firm | Disruptive in the sectors and creates discontinuities within usual patterns of behavior |
| Tai Tsou (2012) | Financial firms in Taiwan | A truly novel e-service product that is very different from industry norms |
| Janeiro et al. (2013) | 967 Portuguese service firms | Radical innovation in services is conceptualized by the incurrence of substantial new technology and that it addresses new customer needs and demands. (in the survey—new to the firm's market) |
| Löbler and Lusch (2014) | IT-related service innovations | Disruptive, where behavior and usage patterns dramatically changes when doing things that either creates a new practice or integrates an old one in a new way |
| Melton and Hartline (2015) | 160 service firms | Having a substantial different core technology and provide substantial higher customer benefits compared to prior products in the category |
| Ryzhkova (2015) | 102 Swedish service firms | Products and processes that are new to the market, the firm being the first to introduce the innovation to the market, not necessarily to the world market |

overall offering. The Lancasterian view takes an internal perspective of what a service innovation is; that is, not taking the perspective of the customer or the effect that the service innovation has on the market. In a further development of the Lancasterian view of service innovation, Windrum and Garcia-Goni (2008) suggested that radical service innovation is a change in service characteristics, which also means radical changes for healthcare customers and for the internal organization of resources.

In addition to the Lancasterian view of service innovation, radical service innovation can be denoted by substantial improvements in technology (Janeiro et al. 2013) or service benefits (Cheng and Krumwiede 2011). This is a narrow way of conceptualizing radical service innovation that, in practice, almost loses relevance due to the very few empirical cases in the service context. According to Barras (1986, 1990) technological service innovations are more of an enabler for later stages of radical service innovation. In sum, many conceptualizations of radical service innovation concern a major change in technology or service characteristics that frequently emphasizes an internal perspective of what a service innovation is.

Further, in contrast to the technological view of service innovation, recent service research has taken a customer perspective on service innovation. Michel et al. (2008) suggested that discontinuous innovations are significant changes in how customers co-create value, which also has a significant effect on market size, prices, revenues, or market shares. Löbler and Lusch (2014) further argued that service innovations alter behaviors and usage patterns that dramatically change how things are done. Gustafsson et al. (2016) argued that the result of using a service, as well as the actual experience, impacts a customer's perceived value of a service. As such, a radical service innovation alters customers experience of a value-creating process. These claims suggest that a radical service innovation should be new from an external perspective.

Finally, a few studies have suggested that a radical service innovation stands out through newness (Harris et al. 2013). Incremental and radical service innovations are often categorized based on innovations that are new to the world and those that are new to the market (Sundbo 1997). Schumpeter (1934) argued that innovation not only creates value for the firm that developed it, but also changes the market in such a way that other companies imitate and follow. Witell et al. (2016) argued that recent developments in service research have departed from this view towards regarding new as a degree of newness, suggesting that all firms develop service innovations.

## 27.3 Conceptualizing Radical Service Innovation in Healthcare

Based on our review of service innovation in healthcare and radical service innovation in service research, we will introduce a framework for incremental and radical service innovation in healthcare. In the framework, we will emphasize two issues:

(1) radical service innovation changes the value-creating process, and (2) the change in the value-creating process influences different actors in the healthcare system. The implications are that radical service innovation can influence the internal value creating process, even though the value proposition is unchanged or viewed as similar to actors outside the organization, such as pharmacies and healthcare customers. In the following sections, we will argue that radical service innovation can be viewed as a major shift in the resource integration practices, experienced internal and/or external to the organization.

### *27.3.1 Incremental and Radical Service Innovation*

The view of radical service innovation as a major change, emphasizing that a radical service innovation is discontinuous from existing services, has its origin in the Schumpeterian view of technological trajectories (Schumpeter 1934). With this definition, service innovation in healthcare could very seldom be seen as radical; that is, there are few completely new value-creating processes based on a new technological trajectory (Barras 1986; Windrum and Garcia-Goni 2008). Such a view of radical service innovation is a poor fit to the healthcare context. Previous research has failed to identify radical service innovations across healthcare organizations (De Vries 2006). Is this a problem, or is it that change in the healthcare sector is driven by incremental service innovation?

As stated in the introduction, the very reasons for having a typology of incremental and radical service innovation is that they need to be managed and developed differently. There is a need to ensure the right amount of resources and purposive action to break, make and maintain institutional arrangements to succeed in implementing a service innovation in practice (Koskela-Huotari et al. 2016). Gustafsson et al. (2016) found that most service innovations are incremental and consist of many small changes in a service ecosystem. One reason for the incremental nature of service innovation is that it takes time to implement and diffuse service innovations. Since the focus of radical service innovation is on new value-creating processes, it often becomes problematic if the innovation is “too radical”. However, incremental service innovations can also have a large influence on value-creating processes and the cumulative effect of several such changes can have a large effect for the different actors (Bolton et al. 2014).

The vast majority of radical service innovations in healthcare practice are internal radical service innovations. By internal radical service innovations, we mean a service innovation that mainly alters the value-creating process for the organization. In general, such service innovations do not influence the value-creating process as experienced by the healthcare customer. Therefore, analyzing service innovations’ radicalness from a “customer only” perspective might bias the idea of how to manage radical service innovations. Similarly, Grönroos and Voima (2013) argued that the lack of description of the roles of the service provider and the customer in the value-creating process makes it hard to understand whom the changes in the value-

creating process address and what kind of effect they might have. Michel et al. (2008) stated that radical service innovations are disrupting the ways in which customers co-create value. However, we argue that such internal service innovations should be characterized as radical, even though they do not disrupt the way healthcare customers co-create value. Our argument is that a great deal of institutional work is needed to establish a new resource integration practices of service innovations, which has major implications for the internal structure of the value creation processes.

Previous research has emphasized the effect of a service innovation as the distinguishing feature between incremental and radical service innovation (see, e.g., Sundbo 1997). Radical service innovation has a more significant effect in terms of profit or that it would be some sort of "game changer" for a firm. However, it is not profits as such that are important for our conceptualization of incremental and radical service innovation. Operating out of a public and private context, the effect must be viewed in a different way. The effect of a radical service innovation can be different depending on who the service innovation is directed towards. The idea of a radical service innovation might come from cost savings, requiring a radical reconfiguration of resources, although in the best-case scenario it has no effect on the care provided. The radical service innovation can also drive new and greater cost compared to the existing value-creating process, yet still have an immense effect on value for the healthcare customer.

Other categorizations of incremental and radical service innovations emphasize that a high level of newness is what constitutes a radical service innovation. Newness is a relative concept (Toivonen and Tuominen 2009). We emphasize that newness is directed towards different entities that need to institutionalize new co-creative practices (McColl-Kennedy et al. 2017) and not if the value proposition is new to the world, market, or the healthcare customer (see, e.g. Oke 2007; Möller et al. 2008; Janeiro et al. 2013). In our conceptualization, the level of newness is directed towards where change of the resource integration practices is taking place. A new pill that would revolutionize treatment of diabetes would probably be a completely new value creating process for the healthcare customer; that is, taking a pill instead of insulin injections. However, such a service innovation would mean minimal change to the hospital care processes for diabetes treatment.

### *27.3.2 A New Conceptualization of Incremental and Radical Service Innovation*

In order to conceptualize radical service innovation and illustrate different types of incremental and radical service innovations, we focused on two dimensions—internal and external; see Fig. 27.1. The first dimension, internal, shows the extent to which the service innovation influences healthcare resource integration practices, with a focus on technological improvements and ways of organizing that has such

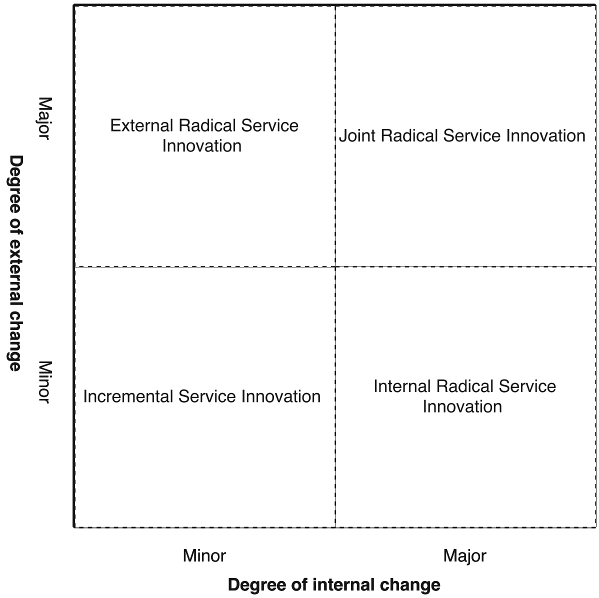


**Fig. 27.1** Incremental and radical service innovation

effects as higher efficiency or cost savings. The second dimension, external, shows the extent to which the change influences external actors resource integration practices, such as pharmacies or healthcare customers, with a focus on such effects as better service or improved wellbeing.

Based on the two dimensions, a service innovation can have either a small or large influence in both dimensions, suggesting that there are four different types of service innovations where the change in resource integration practices addresses internal or external actors.

The first type, incremental service innovation, is based on a small internal and external change. In general, incremental service innovations have minor influences on the service process and the healthcare customer. Examples include minor changes in medications, waiting rooms and the interaction with the physician.

The second type, external radical service innovation, which is represented by a large change in the external dimension combined with a small change in the internal dimension, changes the service process and targets the healthcare customer (or other actors outside the organizations) and their use of the service. The prescription of a change in lifestyle instead of medication could be an example of such an external radical service innovation.

The third type, internal service innovation, is represented by a large change in the internal dimension combined with a small change in the external dimension. Here, the change in the service process is only experienced internally by the healthcare provider. An example is the implementation of a new management control system, such as Lean manufacturing. In such a case, the staff would experience Lean as

**Table 27.4** Different categories of service innovation

| Type | Explanation | Key issues | Effects |
|---|---|---|---|
| Incremental service innovation | A reconfiguration of resources that provide minor changes in the institutional arrangements | To diffuse the changes across healthcare processes to get the effect of the change | Higher quality, lower costs, customer value, and satisfaction |
| Internal radical service innovation | A reconfiguration of resources that changes the institutional arrangements, such as the service provider views the value proposition as new | To break institutionalized arrangements and get acceptance by the value network and frontline employees | Higher quality, efficiency and lower costs |
| External radical service innovation | A reconfiguration of resources that changes the institutional arrangements, such as healthcare customers view the value proposition as new | To get healthcare customers to use the new service. Also, to identify and diffuse service innovations that are in cocreative practices | Higher service quality, customer value, and satisfaction |
| Joint radical service innovation | A reconfiguration of resources that changes the institutional arrangements, such as both internal and external healthcare actors view the value proposition as new | To gain agency for implementation and or development of a new resource integration practice | A combination of higher efficiency and customer value |

completely new, even though the process for the healthcare customer would not change much.

The fourth and last type, joint radical service innovation, is represented by a large change in the internal dimension combined with a large change in the external dimension. It changes the service process experienced by both internal and external actors. An example is the change from hospital care to home-based care for a specific disease. Both the hospital and healthcare customers have to make major institutional changes in order to put such a service innovation into practice.

Past conceptualizations of radical service innovation have not usually distinguished between different types of radical service innovations. Because our conceptualization broadens the perspective of radical service innovation with the change in institutionalized arrangements directed towards different actors, it provides a typology of different radical service innovations, see Table 27.4.

The characteristics of an internal radical service innovation needs to break institutionalized arrangements of resource integration practices. It is directed towards the service provider and the actors in the network. External radical service innovation implies a change in the institutional arrangements of resource integration, such as healthcare customers' use of value propositions. It is directed towards the resource integration of the healthcare customers. Joint radical service innovation emphasizes the coordination between several different actors breaking, making, and

maintaining the resource integration practices (Koskela-Huotari et al. 2016). This means that both internal and external actors' institutionalized arrangements for resource integration are affected. From a service provider perspective, this calls for an extension of their knowledge of the institutionalized arrangements regarding how the healthcare customer and their network integrate and make use of resources.

## 27.4 Implications of a New View of Radical Service Innovation

To further elaborate on the conceptualization of radical service innovation, we will discuss it in relation to the effects of service innovation and diffusion of service innovations. We will also illustrate the mix of public and private actors in healthcare and what it means for service innovation.

### *27.4.1 Effects of Radical Service Innovation in Healthcare*

The suggested conceptualization of radical service innovation focuses on changes in the value creation process. The effect from service innovation in healthcare can come from one radical service innovation or through several incremental service innovations.

The change in the value creation process coming from *internal* radical service innovations can have effects such as cost savings or profits for privately held healthcare units. Internal radical service innovation can even have a large effect on a healthcare customer's value-creating process, even though it is not experienced by the customer. This is achieved by changing the back office without changing the touchpoints throughout the customer journey. Healthcare customers are often not in the healthcare system by choice; they are there because they are ill and are sometimes also scared or angry. This will have an effect of their experience to the value-creating process (Berry and Bendapudi 2007).

The effects of external radical service innovations can be hard to account for, especially in healthcare within the public sector. Healthcare customers have different co-creation practice styles (McColl-Kennedy et al. 2012), which suggests that they act differently to improve their well-being. They are often not familiar with the value-creating process, since many illnesses only are cured once; for example, a person will only have his or her appendix removed once. For a healthcare customer, it might be difficult to uncover the effects of such radical service innovations. In contrast, healthcare customers with chronic illnesses use certain healthcare processes regularly and the illness can be the center point in their life. Hence, these healthcare customers have better knowledge about the service process than the medical staff

themselves, being the best or the only person who can judge whether a service innovation is radical or not.

In order to avoid blurring the difference between incremental and radical service innovations, there is a need to conceptualize service innovation from both an internal and external perspective. For example, in surgery a sedated healthcare customer would not experience a radically new value-creating process as a procedure that might be more cost-effective or more efficient. This suggests that only internal actors will experience the changes in the value-creating process and have to change their behavior. In a healthcare organization, however, such a change would call for institutional change and the making, breaking, and sustaining of resource integration practices (Koskela-Huotari et al. 2016). If healthcare organizations were to have an external perspective on what constitutes a radical service innovation, they might fail to manage the institutional change needed for adopting a radical service innovation. Meaning a major internal change to the resource integration practice, a process in need for vast resources and institutional work. The level of institutional work needed to adopt radical service innovations can explain the few innovations that have a completely new value-creating process within healthcare.

### *27.4.2 Diffusion of Radical Service Innovation in Healthcare*

Previous conceptualizations have described service innovation as following a process of three stages: ideation, development, and implementation (Gustafsson et al. 2016). This view is challenged in the context of healthcare. The process of service innovation crosses several public and private actors, often working in networks (Windrum and Garcia-Goni 2008). Service innovations often emerge as ad hoc solutions for an individual healthcare customer (Gallouj and Weinstein 1997), which emphasizes the institutionalization of a new resource integration practice rather than the diffusion of a technological innovation.

Our conceptualization of service innovation challenges the concept of diffusion. In healthcare, the value creation processes involving healthcare customers and other actors often take place outside the healthcare organization. This suggests that there is often no one responsible for or even acknowledging the new practice as a service innovation. Healthcare organizations often need to expand their value proposition to include healthcare customer practices taking place in different places. By their nature, service innovations are difficult to protect in terms of patents, which could be discouraging from a firm perspective. However, from a public service perspective, diffusion of service innovations can be shared between hospitals, which is beneficial for both the developer and the adopter. In addition, public policy makers imitate service innovations adopted in other service sectors. Since, organizations within the same industry tend to imitate one another in terms of structures and processes (DiMaggio and Powell 1983), imitation enables resource integration practices to be shared between different healthcare organizations and foster diffusion in the healthcare sector. We have learnt from healthcare practice that organizations

with an extended value network outperform others regarding radical service innovation. This means that such organizations outperform other healthcare providers through copying institutionalized resource integration practices performed by other service providers.

### *27.4.3 Healthcare: Why so Few Radical Service Innovations?*

Through this chapter, we have discussed what a radical service innovation is and started to question why there are not more such innovations. First, healthcare consists of both public and private actors, and the reasons for developing and diffusing radical service innovations between them are different. Private actors have a mission to increase profits by acquiring customers and improving profit margins. In contrast, public policy suggests that public actors use service innovation for cost reduction. In healthcare practice, most of the radical service innovations address internal needs. If the service innovations were directed towards external value creation, it would be fair to assume that such innovations would create higher value for healthcare customers. However, this is not easy in the public sector since increased value for healthcare customers does not pay off in a raise in profits.

Windrum and Garcia-Goni (2008) stated that radical service innovations alter the power dynamics in the value constellation and that this has implications for the agency of radical service innovation. Not all actors within the value constellation have the opportunities to break, make, and maintain institutional arrangements. This is consistent with the IT industry, where traditional large corporations are continually buying start-ups for their radical service innovation capability. Since they are bound to their resource integration practices, it is harder to first break their resource integration practice in order to make and maintain others. We argue that this is valid also for public healthcare service providers, as they are bound by institutional norms as risk aversion and safety for healthcare customers (Brown and Osborne 2013). The different levels of actors (as team practice and hospital management) (Grol and Grimshaw 2003) that are influenced by changes in healthcare, make it hard to break, make, and maintain institutional arrangements for radical service innovations. Consider digital primary healthcare units as an example. First, a start-up company started to provide the service of a primary care unit online, through face-to-face video meetings. After a short time, another actor entered the market through offering a platform for the very same service for use by public healthcare providers. Through the platform, public healthcare providers could integrate this service on top of their ordinary primary care units. This suggests that they did not have to break institutionalized practices in order to adapt a radical service innovation.

### *27.4.4 Beyond Healthcare?*

As in healthcare, other public services struggle with service innovation to improve service provision. For example, public transportation in Sweden consists of several actors, both public and private. In public transportation, laws and regulations suggest that the local government has the responsibility to provide public transport for all citizens. The laws and regulations further state that actual service provision should be performed by an external commercial actor selected by a bidding process following a public tendering process. In 2012, a radical service innovation was introduced through laws and regulations to make public transport more attractive to citizens.

The result was more efficient and cheaper public transportation, but this has so far had very little impact on users. Therefore, the change can be viewed as an internal radical service innovation, but with no effects on the external actors. This highlights a complex balance between incremental and radical service innovations. From a customer perspective, incremental service innovations are preferable, especially when incremental service innovations concern improvements in key service characteristics. From a service provider perspective, however, there is sometimes a need for more radical service innovation. In particular, radical service innovation is performed in order to attract new customers to start using public transport. There is a balancing act between incremental service innovations for existing users, on one hand and radical service innovation for the renewal of the business, in this case to attract new users.

## 27.5 Conclusions

The present book chapter develops a new conceptualization of incremental and radical service innovation for healthcare. To provide a better fit with healthcare practice, the present research bridges existing frameworks and provides a conceptualization focusing on both internal and external changes in value creation processes. The conceptualization contains a typology of four types of service innovation, which we encourage service research to use as a starting point for further theoretical development and empirical research.

Healthcare needs service innovation in order to face the challenges of a growing and aging population. The suggested model provides managers a language and understandings with which to discuss incremental and radical service innovations. In particular, it provides a more nuanced view of radical service innovations. This can help healthcare practice to identify ideas of new services that can be further developed and end up as radical service innovations. In particular, it highlights the need for managing the purposive action of institutional work, aimed at different entities in order to diffuse and institutionalize new resource integration practices. We

also argue that there is a need for a balanced focus on internal, external, and joint radical service innovations in order to achieve both internal and external effects.

A lot of service innovation in healthcare concerns incremental service innovation; that is, minor improvements that together have a large effect on healthcare practice. Through the introduction of lean manufacturing in services, incremental innovation to improve healthcare practice has been highlighted. When several such incremental changes are seen in retrospect, their added value can have large effects. Hence, even though radical service innovations can have a large impact, incremental service innovation is important and needs to follow radical service innovation. For example, an internal radical service innovation might need further incremental improvements to address how the new service can be extended to influence the healthcare customer.

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# Part IV
# Challenges – On Rethinking the Theory and Foundations of Service Science

# Chapter 28
# Further Advancing Service Science with Service-Dominant Logic: Service Ecosystems, Institutions, and Their Implications for Innovation

**Melissa Archpru Akaka, Kaisa Koskela-Huotari, and Stephen L. Vargo**

**Abstract** Service-dominant (S-D) logic has been recognized as a theoretical foundation for developing a science of service. As the field of service science advances the understanding of value cocreation in service systems, S-D logic continues to evolve as well. Recent updates and consolidation of the foundational premises establish five core axioms of S-D logic and outline a pathway for understanding the role of institutions in value cocreation in general, and innovation in particular. This chapter overviews the evolution of S-D logic and its service ecosystems view, which can contribute to the furthering the development of service science and advancing the study of innovation in service systems. Future research directions are proposed.

**Keywords** Service-dominant logic · Service ecosystems · Institutions · Innovation

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_28

## 28.1 Introduction

Service science and service-dominant (S-D) logic share a common purpose: the study and understanding of value cocreation (Maglio et al. 2010; Vargo et al. 2010), though with somewhat nuanced approaches. S-D logic has been recognized as a conceptual foundation for the development of service science and the study of service systems (Maglio and Spohrer 2008). It posits that *service*, the application of resources for the benefit of another, is the basis of exchange and a central source of value cocreation (Vargo and Lusch 2004, 2008). This approach provides a framework for conceptualizing service and how value is cocreated in service systems, or dynamic and adaptive webs of interactions among people, organizations, and technology (Spohrer et al. 2007). More specifically, S-D logic establishes a theoretical foundation for the development of service science and the "systematic search for principles and approaches that can help understand and improve all kinds of value cocreation" (Maglio et al. 2010, p. 1).

S-D logic emerged in 2004 through the work of Vargo and Lusch (2004), which integrated a variety of research areas and highlighted the movement toward a service-centered view of exchange and value creation. Since then, S-D logic has evolved into a body of literature that connects traditional service research with a variety of related, emerging and growing research streams, including service science (Wilden et al. 2017). The contributions of numerous scholars have led to the identification of five overarching axioms. Furthermore, it has paved the way for Vargo and Lusch's (2011, 2016) introduction of a service-ecosystems perspective, which is based on S-D logic. We argue that the evolution of S-D logic towards an "ecosystems" view can advance the development of a systematic approach to studying value cocreation and innovation within and among multiple service systems.

*Service ecosystems* are defined as "relatively self-contained self-adjusting systems of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo and Lusch 2016, p. 11). This emphasis on service as the basis of exchange and value creation draws attention to the complex and dynamic nature of the social systems through which service is provided, resources are integrated, and value is cocreated. Furthermore, an ecosystems view emphasizes the importance of *institutions*—social norms or "rules of the game" (North 1990, p. 4–5)—in value cocreation, especially as it relates to innovation. The consideration of institutions as central to value cocreation provides insight into the core resources of service science—technology, people, organizations and shared information (Maglio and Spohrer 2013)—and how and why they may be integrated in certain ways. In this way, a service ecosystems perspective extends the foci of service systems to include the social structures within which the core resources of service science are embedded. The aim of this chapter is to explore how advancements in S-D logic, especially its institutional, ecosystems view, can contribute to further development of service science and the study of service systems, particularly as they apply to innovation.

To this end, we present a service ecosystems approach to further advancing the study of service systems. We elaborate on how a service ecosystem perspective provides a lens for considering embedded levels of interaction and understanding the role of institutions in value cocreation in general, and innovation in particular. This view centers on resource integration as the central means for connecting people and technology within and among service systems. It also emphasizes the social factors that influence, and are influenced by, service-for-service exchange. In particular, the emphasis on the role of institutions in value cocreation requires the reconsideration of the scope of value cocreation and how it influences the actions and interactions of individual actors. As we will discuss in more detail, by considering the importance of institutions in service ecosystems, we can take a more systemic approach to studying how value is cocreated and innovation occurs.

This paper begins with a brief history of the role of S-D logic and its contribution to the development of service science. We highlight the importance of service science and its study of service systems in establishing a systemic perspective of service and value cocreation. We argue that a S-D logic, service ecosystems approach can help to further this initiative. We then outline the core axioms of S-D logic and discuss the importance of institutions and institutional arrangements in value cocreation and innovation. Finally, we discuss why and how service ecosystems view can be used as a transcending framework for thinking about different "types" of innovation, and offer suggestions for future research.

## 28.2 Service Systems and Service Ecosystems

The study of service systems is the heart of service science (Spohrer and Maglio 2010). A service system is "a configuration of people, technologies and other resources that interact with other service systems to create mutual value" (Maglio et al. 2009). Spohrer and Maglio (2010, p. 159) emphasize the importance of socially constructed meaning in service systems and highlight the way in which "symbols guide both internal behavior and mediate interactions with other entities." In particular, the authors suggest that symbols are a central component of service systems, and that "symbol manipulation is increasingly important as a mechanism for value cocreation" (p. 159). In other words, processes of value cocreation draw on the abilities of individual actors in the "manipulation" or reinterpretation of various symbols and development new meanings, and thereby new ways of creating value.

S-D logic is considered as a foundational theoretical framework for service science and the study of service systems (Maglio and Spohrer 2008; Vargo et al. 2010). It has been suggested that a science of service grounded in S-D logic can potentially provide a more comprehensive and inclusive approach than traditional theories related to service and exchange (Vargo et al. 2010). Unlike traditional views of services as intangible units of output, S-D logic conceptualizes service as the application of competences for the benefit of another, which is central to value creation and exchange. Thus, an S-D logic foundation for service science, and its

study of service systems, encompasses the exchange of both tangible and intangible resources, and it emphasizes the processes, rather than the output, of value creation.

The study of service systems has been influenced by prior work connecting S-D logic and with systems thinking (Vargo and Akaka 2009). This research aligns with various theories on systems (e.g., see Barile and Polese 2010; Ng et al. 2011) and provides a conceptual foundation for the consideration of a service system as a "network of agents and interactions that integrate resources for value co-creation" (Ng et al. 2012, p. 1). In general, a systems approach to understanding service-for-service exchange draws attention toward multiple stakeholders (Ostrom 2010) and the importance of systems viability (Barile and Polese 2010) in value cocreation, as well as the emergent nature of service systems themselves (Ng et al. 2011).

S-D logic provides a lens for studying service systems because it centers on dynamic interactions among multiple actors. However, S-D logic also suggests that the reason various actors interact is to exchange resources with the goal of creating value for themselves and for others (i.e., through service provision). The connection between systems theories, S-D logic and service systems has been further extended by a service ecosystems view (Vargo and Lusch 2011). S-D logic advances the understanding of how socially constructed norms and meanings and other institutions mediate value cocreation, by highlighting the way in which all social and economic actors are resource integrators and active participants of value cocreation. A service ecosystems view further emphasizes institutions as a central driver of the actions and interactions that enable innovation (Vargo and Lusch 2011; Vargo et al. 2015). This approach advances the understanding of service science and service systems by drawing attention toward the underlying forces (i.e., institutions) driving interaction and exchange.

According to Vargo and Lusch (2016, p. 11), a service ecosystems view is similar to the concept of a service system within service science. They argue, however, "the 'service ecosystem' definition in S-D logic emphasizes the more general role of institutions, rather than technology," with technology being seen as a specific institutional phenomenon: socially constructed, useful knowledge (Mokyr 2002). What further distinguishes an ecosystem view of service systems is that S-D logic also emphasizes how embedded levels (micro, meso and macro) of social contexts (i.e., institutional structures) (Chandler and Vargo 2011; Edvardsson et al. 2011) influence, and are influenced by, value cocreation processes within and among systems of service exchange.

It is noteworthy that the ecosystems view also explicates the idea that the creation of value is dependent on social contexts—interconnected relationships (Chandler and Vargo 2011) as well as social structures—rules, and resources (Edvardsson et al. 2011; Giddens 1984). However, the relationship between value cocreation and social contexts is recursive, because, as actors engage in exchange, they draw on and contribute to the formation of relationships (Akaka and Chandler 2011) as well as social norms guiding those exchanges (Edvardsson et al. 2011). Vargo and Lusch (2011) have suggested that value cocreation within service ecosystems is driven by the integration of resources, particularly shared institutions—common rules or norms for the governance of interaction. Importantly, S-D logic's emphasis on the

integration of operant resources—those that act upon other resources—points toward institutions (and their social influence) as a primary resource in value cocreation. Because institutions are capable of influencing and guiding action, they can be considered as operant resources. Institutions and institutional arrangements—or assemblages of institutions (Vargo and Lusch 2016)—are an essential element of service ecosystems. Also, because they guide social interactions, institutions can be considered as a necessary resource for value cocreation to occur. The evolution of this research stream has resulted in the development of five core axioms and draws attention to the importance of institutions and institutional arrangements in service ecosystems. This is elaborated in the sections below.

## 28.3 Core Axioms of S-D logic

The essence of the meta-theoretical framework of S-D logic comprises 11 foundational premises (FPs) of which five are identified as axiomatic (Vargo and Lusch 2016). These five axioms, briefly introduced here, represent the core premises from which the other FPs can be derived from (Lusch and Vargo 2014).

### *28.3.1 Axiom 1: Service Is the Fundamental Basis of Exchange*

To understand the meaning of Axiom 1, "Service is the fundamental basis of exchange", it is important to recognize that S-D logic represents a *shift in the underlying logic of understanding exchange*, rather than a shift in the emphasis of type of output that is under investigation. This shift of logic is achieved by introducing a processual conceptualization of *service* (singular)—the application of resources for the benefit of another—as the basis of exchange (Vargo and Lusch 2004, 2008). In other words, the concept of service focuses on the process of serving rather than on a type of output such as services (plural). Consequently, S-D logic is not about making services more important than goods, but about transcending both types of outputs with a common denominator—service.

With the help of this processual conceptualization of the basis of exchange, exchange can be understood as actors applying their competences to provide service for others and reciprocally receiving similar kind of service (others' applied competences or money as 'rights' for future competences) in return. However, (direct) service exchange is often masked, as in our efforts to improve our wellbeing, human kind has come up with several ways to cocreate value more effectively by exchanging service indirectly. Therefore, the concept of service exchange in S-D logic is not tied to the distinct moments of direct physical interaction among people (Vargo 2008) as is the case in the conventional literature on services (Lovelock 1983;

Zeithaml et al. 1985). Instead, a crucial feature of S-D logic is that service is also provided indirectly, for example, in a form of a product (i.e., vehicle for service provision) or monetary currency (i.e., rights for future service).

### *28.3.2 Axiom 2: Value Is Cocreated by Multiple Actors, Always Including the Beneficiary*

S-D logic's conceptualization on value creation significantly differs from the linear and sequential creation and destruction of value emphasized in G-D logic (Wieland et al. 2016). Rather than placing the firm as the primary value creator and focusing on the value contributing activities among two actors (usually a firm and a customer), S-D logic argues for the existence of more complex and dynamic exchange systems within which value cocreation occurs at the intersections of activities of providers, beneficiaries, and other actors (Vargo and Lusch 2011; Wieland et al. 2012). Alternatively stated, S-D logic posits that value is *cocreated by multiple actors* through integration of resources in a specific context, rather than manufactured and then delivered (Vargo et al. 2008).

This implies that for value cocreation to occur there must be integration of the beneficiary actor's resources with those applied by the service provider. All of this, in turn, implies that the beneficiary is always an active participant of the value cocreation process, that is, every time value emerges as a result of resource integration, it is always cocreated by multiple actors. Furthermore, according to the S-D logic view on value cocreation, value unfolds over time and all the resource integrating actors and their activities preceding a specific instance of value determination by an actor, are seen as cocreators of value (both for that actor and to themselves). In other words, value creation does not just take place through the activities of a single actor (e.g. customer) or between a firm and its customers but among a whole host of actors. That is, "at least in specialized, human systems (and arguably in all species), value is not completely individually, or even dyadically, created but, rather it is created through the integration of resources, provided by many sources, including a full range of market-facing, private and public actors" (Vargo and Lusch 2016, p. 9).

### *28.3.3 Axiom 3: All Social and Economic Actors Are Resource Integrators*

As explained, S-D logic argues that all actors provide service (apply resources for other's benefit) to receive similar service from others (other actors applying their resources) in the effort of cocreating value (Vargo and Lusch 2011). This means that all actors are both providers and beneficiaries of service and the activities and

characteristics of actors are not fundamentally so dichotomous as implied by the conceptual division of the 'economic' actors into producers and consumers. Hence, the axiom 3 "All social and economic actors are resource integrators", implies an *actor-to-actor* (A2A) orientation that urges to move away from such restricted, pre-designated roles (e.g. "producers" vs. "consumers", "firms" vs. customers") to a more generic understanding of actors (Vargo and Lusch 2011). This suggestion has wide-ranging implications because it signals that all actors fundamentally do the same things: integrate resources and engage in service exchange, all in the process of cocreating value (Vargo and Lusch 2016). Vargo and Lusch (2011) argued that the discussion in business-to-business (B2B) marketing, rather than the traditional business-to-consumer (B2C) orientation, offers a better exemplar of the A2A orientation. This is because, B2B does not view actors as strictly producers or customers that are fundamentally different from one another but, rather, all actors in this discussion are considered as enterprises (of varying sizes, from individuals to large firms), engaged in the process of benefiting their own existence through benefiting the existence of other enterprises, either directly or indirectly. This is well-aligned with the idea of actors as active integrators of resources.

Resources in S-D logic are viewed "*as anything, tangible or intangible, internal or external, operand or operant, an actor can draw on for increased viability*" (Lusch and Vargo 2014, p. 121, emphasis in original). The literature regarding resources in S-D logic recognizes two broad types of resources that are being integrated (Lusch and Vargo 2014; Vargo and Lusch 2004). First type is operand resources which refers to those resources that require action taken upon them to be valuable. Second type is operant resources which refers to the resources that are capable of acting on other resources to contribute to value creation. Aligned with many of the resource-based views (Barney 1991; Penrose 1959/2011), S-D logic emphasizes the primacy of operant resources over operand resources in value co-creation. In other words, although operand resources often contribute to the cocreation of value, without the application of operant resources, such as knowledge, skills and competences, value co-creation does not occur (Vargo and Lusch 2004).

An important part of the S-D logic view on resources is to understand the nature of resources as processual and contextual. In other words, *resources are not, they become* (De Gregori 1987; Vargo and Lusch 2004). This means that actors' knowledge and skills, that is, other resources, determine the *resourceness* of resources (Koskela-Huotari and Vargo 2016; Lusch and Vargo 2014). Consider for example fire, the resourceness of fire only became available for humans once the knowledge and skills to control and apply fire for specific purposes were developed. Hence, potential resources become resources, when appraised and acted on through integration with other potential resources.

### 28.3.4 Axiom 4: Value Is Always Uniquely and Phenomenologically Determined by the Beneficiary

In S-D logic, the purpose of human action is conceptualized as the cocreation of value. However, in this view, value is derived and determined in a particular context (Chandler and Vargo 2011; Vargo et al. 2008). More specifically, value is considered to be an emergent outcome of the resource integration and service provision practices that can be described as "an increase in the well-being of a particular actor" (Lusch and Vargo 2014, p. 57, italics in original). The perception of this value is phenomenologically determined by each actor in their respective (social) context (Chandler and Vargo 2011; Edvardsson et al. 2011; Vargo and Lusch 2008).This means that value is perceived experientially and differently by varying actors in varying contexts and each instance of value co-creation can have multiple possible assessments, including negatively valenced ones (Vargo et al. 2017).

The contextual and phenomenological nature of value determination should not, however, be confused with randomness or naive subjectivism. Instead, S-D logic argues that value determination, like value cocreation, is guided by social structure and the complex constellations of institutional arrangements it comprises (Siltaloppi et al. 2016; Vargo and Lusch 2016). In other words, "value-in-context suggests that value is not only always cocreated; it is contingent on the integration of other resources and actors" (Lusch and Vargo 2014, p. 23). The systemic and institutional conceptualization of value enables reconciling the separation of value-in-use and value-in-exchange because it provides the means for considering various aspects of value—how and through which institutional arrangements it is determined through use, as well as how and through which institutional arrangements it is captured in exchange (cf., Vargo et al. 2017).

### 28.3.5 Axiom 5: Value Cocreation Is Coordinated Through Actor-Generated Institutions and Institutional Arrangements

Recently, the need to articulate more clearly the mechanisms that enable and constrain the often massive-scale cooperation involved in value cocreation, was made apparent by S-D logic's movement toward a systems orientation and more specifically the introduction of the service ecosystems perspective discussed earlier in this chapter (Vargo and Lusch 2011, 2016). Hence, axiom 5, "Value cocreation is coordinated through actor-generated institutions and institutional arrangements," was added to emphasize the importance of *institutions*. The concept of an institution and, more specifically, *institutional arrangements*—sets of interrelated institutions—as used in S-D logic, should not be confused with the more everyday use

of the word 'institutions' referring to firms, governmental agencies or any such organizations. Instead, institutions in a sociological sense, refer to humanly devised rules, norms, and beliefs that enable and constrain action and make social life predictable and meaningful (Vargo and Lusch 2016).

Hence, institutions as coordination mechanisms of value cocreation consist of formalized rules and less formalized norms defining appropriate behavior, as well as cultural beliefs and cognitive models, frames and schemas encapsulating the often taken-for-granted assumptions and beliefs fundamental to guiding social action in different situations (cf. Scott 2014). Following Giddens' (1984), S-D logic views institutional arrangement as the social structure that is both the medium and outcome of human action. In other words, institutional arrangements are not exogenous to service ecosystems and the actors they comprise, but socially constructed and internalized by them (cf. Berger and Luckmann 1967). In other words, institutions and institutional arrangements represent the structure of social systems that lend them their systemic form (Giddens 1984) and in a slightly more narrow sense can be thought as the actor-generated "rules of the game" in a society (North 1990) that enable and constrain the way resources are integrated, and value is both cocreated and determined (Vargo and Akaka 2012; Vargo and Lusch 2016; Wieland et al. 2016).

## 28.4 The Importance of Institutional Arrangements in Service Ecosystems

As explained, in S-D logic, institutions and institutional arrangements are viewed as the actor-generated coordination mechanism of service ecosystems and, therefore, the keys to understanding their functioning (Vargo and Lusch 2016). This emphasis on collective values and meanings aligns with prior discussions of symbols in service systems (Spohrer and Maglio 2010). However, the discussion of institutions and institutional arrangements in service ecosystems sheds light on how and why symbols gain their meaning and offers additional insights into how people act and interact in their efforts to create value. The role of institutions in shaping meaning (symbols) and interaction stems at least in part from the fact that, contrary to the assumptions of neoclassical economics, human beings have limited cognitive abilities (Simon 1996). Institutions represent the socially constructed aides that provide shortcuts to cognition, communication, and judgment. In fact, if actors appear to be rational in a given situation, it means they are guided by an institutional arrangement that is shared and generally acknowledged as the appropriate and logical in that situation. Hence, actors do not appear rational despite of institutions, but because of them (cf. Friedland and Alford 1991).

As described, institutions come in many forms including formal laws, informal social norms, beliefs and meanings (cf. Scott 2014). Institutions also do not usually exist independently of other institutions, but as part of more comprehensive,

interrelated institutional arrangements (Vargo and Lusch 2016). A conceptual distinction between an institution and institutional arrangement can be, however, useful as individual institutions can work as the building blocks for the ongoing formation and reformation of multiple, increasingly complex assemblages. Thus, in S-D logic the word "institution" is used to refer to a relatively isolatable, individual "rule" (e.g., norm, meaning, symbol, law) and "institutional arrangements" to refer to a relatively coherent assemblage of institutions that facilitates coordination of activity within service ecosystems.

When more actors share an institutional arrangement the greater the potential coordination benefit is to all of these actors, due to the network effects with increasing returns. Vargo and Lusch (2016) argue that institutions enable actors to accomplish an ever-increasing level of service exchange and value cocreation under time and cognitive constraints and, therefore, the formation of ever-more complex service ecosystems. However, while the guidance of institutional arrangement enables value cocreation is the first hand, it also comes at a potential expense. That is, the ability of "performing without thinking" (Whitehead 1911) is inherently susceptible to acting without reevaluating the appropriateness of the institutions for the context at hand (Vargo and Lusch 2016). Thus, institutions can lead to the development of the "iron cage" (DiMaggio and Powell 1983), that is, ineffective dogmas, ideologies, and dominant logics within a field that hinder innovation and change. Because of this, it is important to investigate how institutions can foster innovation in some cases and restrain it in others. In other words, an exploration of how a service ecosystems perspective can provide a dynamic approach to studying innovation is needed in order to advance the development of novel and compelling, potentially disruptive solutions.

## 28.5 Service Ecosystems Perspective as a Unifying View of Innovation

Innovation is central to the continuation of value cocreation and the enhancement of wellbeing. However, the fragmented nature of the innovation literature suggests that there are multiple processes of innovation depending on the "type" of innovation involved. This makes it difficult to assess the underlying driver of innovation and how institutions can be leveraged to help foster the cocreation of new solutions. Recognition of different types of innovation originated with Schumpeter's (1934) identification of five areas of innovation—product innovation, process innovation, market innovation, input innovation and organizational innovation (see Abernathy and Clark 1985). Although most of these types of innovation referred to products or processes, Schumpeter (1934) recognized market innovation as a distinct type of innovation as well.

More recently, Abernathy and Clark (1985) separated innovation into two domains of innovative activities: technology/production and market/customer. In

their view, the "technology" side of innovation focuses on the production and operation processes involved with the design and development of new products. Alternatively, the "market" side of innovation focuses on the distribution of products and the development of relationships with customers. Along these lines, Hauser et al. (2006) identified five fields of research on innovation that center on the development of new technologies (i.e., organizations and innovation, and prescriptions for product development) and understanding the markets within which technologies are adopted or diffused (i.e., consumer response to innovation, strategic market entry, and outcomes for innovation).

A service ecosystem perspective denotes both an institutional and systemic orientation on innovation (Vargo et al. 2015). Understanding how innovation emerges is increasingly vital for the continuation of value creation in dynamic and interconnected service systems. In order to maintain viability of service systems, it is necessary to continually identify new solutions to increasingly complex problems. In the following, we highlight some of the most important areas for further research implied by these two, intertwined orientations and how they can further develop service science and the study of innovation within service (eco)systems.

### *28.5.1 Innovation as an Emergent Property of Service Ecosystems*

So far, previous work using a service ecosystems perspective to study innovation has mainly focused on detailing the institutional rather than the systemic aspects of innovations (see e.g., Koskela-Huotari et al. 2016; Vargo et al. 2015). However, there is recent work that argues that one of the basic concepts from systems thinking—*emergent property* (Georgiou 2003)—could be used to extend the service ecosystems perspective's conceptualization of innovation (Koskela-Huotari 2018). According to systems thinking (see e.g., De Haan 2006; Harper and Lewis 2012), emergence occurs when a whole system (e.g., an organization) produces outcomes that differ qualitatively from those produced individually by the parts of the system (e.g., individual members of the organization). Thus, an emergent property is "a property of a system that is dependent upon the connective structure of the system's elements" (Harper and Lewis 2012, p. 329). Hence, emergence is not only about the emergent outcomes, but also the interactions between the elements that cause the coming into being of those properties, that is, the activities and mechanisms producing novelty. In other words, the understanding of innovation as an emergent property of service ecosystems requires the understanding of both the outcome and the process that brings it into being. This points to several avenues for future research to better understand the role of institutions and the systemic processes and outcomes that enable innovation.

Previous research has argued that institutional work, that is, the actions of individual and collective actors aimed at creating, maintaining, and disrupting

institutions (Lawrence and Suddaby 2006), provides a fruitful way to understand the process aspects of innovation as an emergent property (Vargo et al. 2015; Wieland et al. 2016). In other words, innovation can be seen as a process of changing value cocreation practices in service ecosystems that entails reconfiguring the institutional arrangements the actors are enacting. Furthermore, the service ecosystems perspective's "oscillating foci" (Chandler and Vargo 2011), that is, the ability to zoom in and out on phenomena, can be used to examine institutional work at different levels of aggregation as done by Koskela-Huotari et al. (2016). This means that the service ecosystems perspective enables the analysis of value cocreation and innovation on a broader level of aggregation (e.g., institutional work and its outcomes in an industry) to grasp the multitude of actors engaging in it, as well as attending to the micro-processes of a chosen focal actor (e.g., institutional work done by a specific organization or individual and its outcomes).

One way to attend to the static aspects innovation as an emergent phenomenon is to view it as a proto-institutional outcome (Koskela-Huotari 2018). In institutional theory, novel social elements (e.g., new practices, technologies, and rules) that are narrowly diffused and only weakly entrenched, but have the potential to become widely institutionalized, are referred to as *proto-institutions* (Lawrence et al. 2002; Zietsma and McKnight 2009). Stated differently, proto-institutions are institutions-in-the-making: They have the potential to become full-fledged institutions if social processes develop that entrench them and they are diffused throughout an institutional field.

Lawrence et al. (2002) proposed a theoretical framework in which novelty arises in collaborations. This fits well with the earlier argument of viewing innovation as an emergent property that depends on the connective structure of the system's elements. At this point, however, a specific collaboration has not produced any institutional effects on a meso- or macro-level of aggregation. Instead, a change has occurred, but only within the boundaries of the initial collaboration. In some cases, these novel elements (e.g., novel resourceness of resources or value cocreation practices) diffuse beyond the boundaries of the specific group of actors among which they were developed, and they are internalized by other actors in the field. In such cases, they become proto-institutions. In other words, proto-institutions represent the important first steps in the processes of creating institutions, thereby potentially forming the basis for broader, field-level change, such as market evolution.

It is clear that future research is needed to better understand how institutions in general, and proto-institutions in particular, emerge and evolve. Furthermore, how institutions relate to each other in institutional within institutional arrangements is still unclear. Some research questions that could help move this exploration forward include:

1. What is the role of dominant institutions in the emergence of proto-institutions?
2. How do proto-institutions emerge?
3. What is the relationship among institutions within an institutional arrangement?
4. How do people draw on different institutions in their efforts for value creation?
5. How do the relationships among institutions influence innovation?

### 28.5.2 Prerequisites for Innovation in Service Ecosystems

Along the lines of institutional change, understanding the antecedents of innovation is important for understanding how new forms of value are cocreated. As discussed, institutions both enable and constrain value cocreation within service ecosystems and, therefore, are instrumental for these activities by providing the building blocks for increasingly complex ecosystems. However, all actors with a service ecosystem do not necessarily share the same institutions, hence situations within which actors operate in the guidance of misaligned institutional arrangements can occur. Furthermore, actors in nested and overlapping service ecosystems can be guided by multiple institutional arrangements simultaneously (cf. Thornton et al. 2012). According to Siltaloppi et al. (2016) it is when this institutional pluralism—the co-existence of multiple inhabited institutional arrangements—turns into institutional complexity—incompatible prescriptions given by multiple institutional arrangements in a single situation than changes can occur within service ecosystems. In other words, institutional complexity can be seen as a prerequisite of innovation in service ecosystems.

Siltaloppi et al. (2016) argue that this is because, on the one hand, the coexistence of incompatible institutional arrangements elevates actors' conscious and reflective problem solving by reducing the taken-for-grantedness of institutional arrangements. On the other hand, institutional complexity makes available multiple institutional "toolkits," consisting of the cultural norms, meanings, and material practices comprising different institutional arrangements. The availability of multiple institutional toolkits enables the creative reconstruction of value cocreation practices in service ecosystems as actors can reconcile, transform, and integrate elements within them. It is, however, important to note that institutional complexity does not necessarily lead to the emergence of novelty; rather, it can also result in behavior in which countering alternatives leads to action aimed at maintaining the status quo (Siltaloppi et al. 2016). The emerging discussion of reflexivity in institutional analysis in organization studies (Suddaby et al. 2016) can be a productive area of further investigation. Hence potential further research questions, include for example:

1. Under which conditions does institutional pluralism turn into institutional complexity?
2. What factors determine whether institutional complexity results in divergent or convergent change?
3. What happens to value cocreation when institutions are misaligned?
4. Are there optimal situations of institutional complexity that can lead to innovation?
5. Do different types of networks or relationships lead to different value outcomes?
6. What are the main elements of a service ecosystem that lead to institutional change?

### 28.5.3 *Technology as an Operant Resource in Innovation*

Understanding the role of resources in innovation is important for further development of service science. In line with S-D logic's distinction between operant and operand resources, Maglio and Spohrer (2008) recognize four categories of resources in service systems: (1) resources with rights, (2) resources as property, (3) physical entities, and (4) socially constructed resources. Just as S-D logic focuses on the primacy of operant resources in value co-creation and the influence of institutions in service ecosystems, Spohrer and Maglio (2010, p. 159) also suggest that socially constructed resources are "increasingly important as a mechanism for value co-creation." In particular, the authors argue that symbols are a central feature of service systems, and processes of value co-creation often require the abilities of individual actors to "manipulate" or re-interpret symbols in service systems to develop new meanings, and ultimately new ways of creating value. This suggests that operant resources are not only important for cocreating value, but they are also the central resources in developing new ways for creating value (i.e., innovation).

S-D logic's emphasis on operant resources and systems of service exchange highlights the social processes that foster innovation, or institutional change (Vargo et al. 2015). The consideration of technology as an operant resource (Akaka and Vargo 2014) suggests that innovation is as a process for doing something, as well as an outcome of human action and interaction (Arthur 2009). In this view, innovation occurs, not only through the individual actions of humans (e.g., design), but also through the interaction among multiple actors and the recombination of practices and resources. This view of technological advancement falls in line with Arthur's (2009) notion of technology as an assemblage of practices and components as well as a means to fulfill a human purpose. It is important to note, however, that material artifacts remain an important component in many, if not all, technologies. When an artifact is institutionalized within a service system, it becomes a symbol (Spohrer and Maglio 2010), which represents particular practices and is associated with particular meanings.

Although S-D logic provides a framework for reconsidering value creation and service innovation, the nature and role of technology in service innovation has not been fully explored. Understanding the role of technology is important for understanding value co-creation and service innovation because it is one of the central components of service systems and a key driver of value co-creation and innovation. Thus, there is a need to further investigate the role of different types of resources in innovation in general and technology in particular. The following questions can help guide future research in investigating how particular resources and integration processes can influence innovation:

1. Does technology have agency within a service ecosystem?
2. How do resources "become" through innovation?
3. How are practices assembled to form new technologies?
4. Why does market innovation happen in some cases but not others?

## 28.6 Conclusion

The service ecosystems perspective presented highlights the importance of institutions in value cocreation and innovation. We argue that a service-ecosystems perspective helps to extend a service system view by emphasizing the role of institutions in shaping the integration of resources, such as people, organizations, technology and information and identifying institutionalization as a central process for the innovation. In this view, the underlying process by which different "types" of innovation occur is, ultimately, one and the same. More specifically, technological innovation can be conceptualized as the combinatorial evolution of useful knowledge, which is enabled and constrained by existing institutions and influenced by the ongoing negotiation and recombination of overlapping institutions (i.e., social technology). In other words, the development of a new technology includes a process of institutional maintenance, disruption and change (i.e., institutional work). This requires the integration of existing technologies with existing institutions and results in the development of new value propositions.

Along these lines, market innovation can be viewed as resulting in a broader institutionalization of new solutions. Both processes are driven by institutionalization but, whereas technological innovation results in the development of a new value proposition, market innovation results in the development of a new institutionalized solution. Furthermore, both processes are driven by the ongoing cocreation of value among multiple actors, within ecosystems of service exchange. Importantly, as new solutions become institutionalized they recursively contribute to the exchange of service and the cocreation of value. This emphasis on institutions in innovation contributes to the further advancement of service science and study of service systems by (1) broadening the overall innovation process to include the influence and change of institutions, and (2) extending the focus of innovation beyond technological advances to understanding social change. This broader perspective requires the consideration of institutional work and institutionalization, but also enables a deeper understanding of technological innovation, more specifically. Furthermore, this approach can inform business model innovation (Wieland et al. 2017), which is important for understanding how organizations can design compelling value propositions (Maglio and Spohrer 2013).

As institutions both enable and constrain the cooperation among resource-integrating actors in service ecosystems, they are critical to understanding and enabling economic growth. Through the inclusion of institutions and institutional arrangements in its narrative of value cocreation, S-D logic can provide managers and policy makers a practical perspective for viewing and understanding continuous and discontinuous innovation. A service ecosystem perspective sheds light on how discontinuous innovation, almost always leading to creative destruction, is heavily intertwined with de-institutionalization and reinstitutionalization (Vargo et al. 2015). It also shows that all types of actors are a part of the innovation process in a fundamentally similar way, but that different types of actors are often faced with at least somewhat different institutions and institutional arrangements (Wieland et al.

2016). Innovation is, therefore, not only the result of "producers" and "inventors," but includes a much wider range of actors. This suggests that an institutionally informed service ecosystem perspective on innovation and other forms of the growth of human wellbeing needs more exploration and attention.

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# Chapter 29
# On the Ethical Implications of Big Data in Service Systems

**Christoph F. Breidbach, Michael Davern, Graeme Shanks, and Ida Asadi-Someh**

**Abstract** Big data analytics is a fast evolving phenomenon, and understanding its impact on service systems is a key research priority for service science. However, there is very little knowledge related to the potential ethical implications associated with the use of big data analytics in service today. This chapter therefore aims to identify some ethical implications that can arise in data-driven service systems. It is relevant to those who use big data to generate new value propositions, and for those who cocreate value in this context. The chapter also aims to inform managerial and policy guidelines for implementing, and ethically benefiting from, big data analytics in service.

**Keywords** Algorithmic decision making · Big data · Ethics · Society

## 29.1 Introduction

Information and Communication Technology (ICT) is critical for many services, and service settings are critical contexts for the use for ICT. It is therefore unsurprising that the need to investigate the role of ICTs in service has been acknowledged as a key research priority in service science (Maglio and Breidbach 2014; Srinivasan et al. 2015; Ostrom et al. 2015), but also highlighted as an increasingly important area of inquiry for Information Systems (IS) research for some time (Rai and Sambamurthy 2006; Brust et al. 2017). Today, big data analytics emerged as the leading edge of information systems (McAfee and Brynjolfsson 2012) and service research (Rust and Huang 2014). In fact, exploring the role and impact of big data analytics in service even represents the current service research priority with the

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_29

widest gap between perceived importance and available knowledge (Ostrom et al. 2015).

Big data analytics translates ‘big’ data, the result of our new ability to collect, store, and process increasingly large and complex data sets from a variety of sources into competitive ad-vantages. Unsurprisingly, the current discourse in the service science field is dominated by the prospective benefits and advantages associated with the use of big data. These may range from service innovations (Breidbach and Maglio 2015; Antons and Breidbach 2018), to new business models (Mayer-Schönberger and Cukier 2013), improved healthcare (Murdoch and Detsky 2013), or highly personalized customer service experiences (Rust and Huang 2014). However, despite these benefits, there are also potentially negative and unethical consequences for service systems (e.g., Zuboff 2015). And while ethical concerns associated with the use of ICT are not new to the IS literature (e.g., Smith and Hasnas 1999), the increasingly important intersection of ethics and big data remains entirely untouched in the service science field. This gap in knowledge will be increasingly important because, as the capabilities of big data analytics continue to grow, the ‘datafication’ of service is not just imminent, but unavoidable (Rust and Huang 2014), so that potentially more wide-reaching ethical challenges related to the use of big data analytics are likely to emerge within many service systems in the near future.

Our present work builds on definitions of business ethics as the “moral rules, codes, or principles which provide guidelines for right and truthful behavior in specific situations” (Lewis 1985, p. 382), and aims to initiate a critical discourse that exceeds the focus on the prospective benefits associated with big data analytics that dominated service research to date. Specifically, our chapter develops a conceptual framework to guide future service researchers and practitioners in successfully, and ethically, developing and managing data-driven value propositions. We provide the necessary terminology to confront some ethical consequences of big data analytics that may arise for service providers, their customers, and society at large. We outline how the inclusion of big data analytics in service systems can re-define the structure and roles of service system actors as cocreators of value, and how these changing structures culminate in ethical challenges ranging from algorithmic decision-making to predict individual behavior, the intentional or unintentional profiling and surveillance of individuals, or information value net-works where data is used for purposes other than originally intended. Our chapter thereby contributes to this second volume of the *Handbook of Service Science* by addressing current service research priorities that called to explore the implications of big data for service (e.g., Ostrom et al. 2015), as we approach the topic from the much-needed managerial rather than technical viewpoint (McAfee and Brynjolfsson 2012).

Our manuscript is organized as follows: We initially discuss the role of big data in service systems by integrating service science, information systems, and technology management literature. We then analyze value cocreation processes in data-driven service systems, before de-scribing and discussing some key ethical challenges that may arise in this context. Our chapter concludes with a thorough discussion and delineates potential ways forward.

## 29.2 Big Data and Service Systems

Today, technology-enabled human-to-human, human-to-machine, or machine-to-machine interactions result in big data sets that transform service systems at an unprecedented scale. For example, retailing behemoth Wal-Mart analyses the data from over one million customer transaction every hour—the equivalent of 167 times the books stored in the US Library of Congress, while social networking site Facebook stores an estimated 40 billion photos on its servers (Economist 2010). It is therefore unsurprising that big data is gaining attention in disciplines like information systems (Chen et al. 2012), management (McAfee and Brynjolfsson 2012), marketing (Rust and Huang 2014), and service science (Maglio and Breidbach 2014; Ostrom et al. 2015; Antons and Breidbach 2018). And while some deem data to be one of the most significant economic resources available today (e.g., Manyika et al. 2011), definitions of what constitutes "big" data sets still vary. For example, Mayer-Schönberger and Cukier (2013) argue that big data needs to be measured in relative, rather than absolute terms, while others stipulate that big data exists when-ever advanced storage, management, analysis, and visualization techniques are needed (Chen et al. 2012). However, the most common approach to define big data builds upon its perceived at-tributes of high volume, velocity, variety (McAfee and Brynjolfsson 2012), and unknown veracity (Schroeck et al. 2012).

High volume is typically associated with big data, but what exactly counts as 'high' volume, varies across industries and contexts (Schroeck et al. 2012). For example, stock exchanges routinely collect and analyze petabytes of data, whereas service systems like utilities have just begun to recognize that they, too, operate in a data-rich environment (McAfee and Brynjolfsson 2012). The velocity, or speed, with which data is created has also increased: 90% of the world's data was generated in the last 2 years, a trend that is expected to continue (Manyika et al. 2011). As the volume and velocity of data increases, so does its variety; for instance, over two billion videos are watched on YouTube each day, which creates multiple data trails ranging from customer click-streams or comments, to user profiles and video-data (Rust and Huang 2014). Veracity describes the uncertainty inherent in some data sources, such as weather or economic data (Schroeck et al. 2012). Finally, regardless of how to define big data, just like traditional data mining techniques (Chen et al. 2012), the analysis of big data aims to translate data-driven insights into competitive advantages (Manyika et al. 2011).

Some scientific disciplines like astronomy or physics have operated in a big data environment for a long time, and computer science consequently focused on technical questions concerning the collection, storage, querying, and analysis of big data (Chen et al. 2012). However, the most pressing, and yet to be explored challenges related to big data are managerial, and therefore broadly associated with the social sciences (McAfee and Brynjolfsson 2012). Social scientists, including service scholars, are just beginning to explore the implications and opportunities related to big data analytics (Maglio and Breidbach 2014), but have not yet developed the necessary knowledge and skills to do so (Rust and Huang 2014; Ostrom et al. 2015).

This gap in knowledge is therefore a key challenge because the potential ability of big data analytics to improve service systems has been recognized in a variety of contexts; service innovations (Breidbach and Maglio 2015), new business models (Mayer-Schönberger and Cukier 2013), or improved healthcare (Murdoch and Detsky 2013), as well as highly personalized customer service experiences (Rust and Huang 2014) and operations (Rust and Huang 2014), are but some benefits commonly associated with analyzing big customer data in service. However, we argue that the current discourse in the service science field is largely biased towards prospective benefits and advantages associated with the use of big data analytics in service. The current discourse is therefore inherently limited because there are also potentially negative and unethical consequences associated with the use of big data analytics for service systems (e.g., Zuboff 2015). And while computer science (e.g., Stahl et al. 2014) or IS researchers (e.g., Smith and Hasnas 1999) already explored ethical concerns associated with ICTs more broadly, and big data analytics more specifically (e.g., Zuboff 2015; Asadi-Someh et al. 2016), the intersection of ethics, big data analytics, and service remains an entirely untouched area of inquiry to date. This is a key challenge because, as the capabilities of big data analytics continue to grow, the 'datafication' of service is not just imminent, but unavoidable (Rust and Huang 2014). We therefore anticipate that technological advances associated with big data in service will eventually result in a large array of ethical dilemmas with potentially more wide-reaching implications.

## 29.3 Cocreating Data-Driven Service

We adopt a service science lens to explore how big data analytics can unethically impact service systems. As such, we address the aforementioned need for scholarship in the domain from a social science, rather than computer science or technical perspective. As service scientists, we are guided by the basic principles of service science (Maglio and Spohrer 2013), which initially leads to three broad areas when exploring data-driven service systems: service system performance, innovation and implementation (Maglio and Spohrer 2013), as well as value cocreation between economic actors (e.g., Vargo and Lusch 2004). We discuss each in turn.

On the most basic level, service is an interactive and collaborative process that involves multiple economic actors. For one, service 'provider' create and offer value propositions by applying specialized knowledge and skills for the benefit of 'customers', who may realize the value embedded in these propositions through use (Vargo and Lusch 2004) or experience (Grönroos 2011). Service, therefore, is value cocreation and takes place in service systems, the main unit of analysis in service science (Vargo and Lusch 2016). Service systems are thereby abstract representations of value cocreation, and consist of configurations of resources (including people, information, and technology) that are connected by value propositions.

The performance of service systems is contingent on the ability of each economic actor within a service system to access, exchange, and integrate resources in the

context of their own reality (Maglio and Spohrer 2013). In the context of data-driven service, one key resource is of course data itself. The main intention behind many data-driven service innovations are to instill a shift from standardization to personalization, as every single economic actor (e.g., customer), rather than groups of customers, may constitute a separate market segment (Rust and Huang 2014). With big data, service systems can alter value propositions internally, in response to changing customer preferences. Alternatively, by collecting new data sets, or by combining previously unrelated data sets like weather patterns and electricity usage, a firm may generate immediate benefits for itself or others, given perceived value of the data (i.e. data-as-a-service) (Demirkan and Delen 2013). Finally, in order to benefit from big data analytics, organizations will need to invest in the implementation of the appropriate tools, method and organizational processes. While not every firm may be willing to invest in the technical infrastructure, opportunities for new value propositions (i.e. analytics-as-a-service) will likely emerge as well (Maglio and Breidbach 2014).

When attempting to conceptualize value cocreation in data-driven service systems, it is important to acknowledge that this process "does not just take place through the activities of a single actor (customer or otherwise) or between a firm and its customers, but among a whole host of actors. That is [. . .] value cocreation [. . .] is neither singular nor dyadic but rather a multi-actor phenomenon, often on a massive scale, albeit with the referent beneficiary at the center" (Vargo and Lusch 2016, p. 10). The inclusion of big data analytics in service systems, however, can re-define the structure and roles of systemic actors as cocreators of value. Specifically, we argue that while value cocreation itself remains a multi-actor phenomenon, it can become unclear as to who the beneficiary of many data-driven services really is, and if, how, and to what extent each actor contributes to this process of resource exchange. We therefore differentiate between three archetypical service system actors, namely the service provider, service customer, but also the data customer. We furthermore argue that within value cocreation processes, each actor's perception of the value proposition, resource exchange, and value-in-use differs, and that their diverging roles, actions, and intentions can lead to unethical consequences that are currently unexplored in the service science literature. Table 29.1 provides an overview of our framework, using social media, web applications and sensor-based smart services (e.g., Beverungen et al. 2016) as examples.

The value proposition of data-driven service systems differs for each actor. For example, service customers might perceive the value proposition of social media networks (e.g., Face-book) as an opportunity to build or maintain social connectedness with others, while numerous web applications and ecosystems (e.g., Google) promise to satisfy information seeking needs while also providing digital collaboration platforms (e.g., in the form of text, image, or data processing) (Breidbach et al. 2014; Breidbach and Brodie 2017). Similarly, some car insurance companies (e.g., Allstate) provide incentives for customers to install sensors into their cars to track driving behavior in exchange for reduced premiums that reward careful driving. Unlike in technology-enabled value cocreation processes, where human economic actors interact with one another (e.g., Breidbach and Maglio 2016), value cocreation

**Table 29.1** The dynamics of cocreating data-driven service

| Example | Service system actor | Value proposition (intention, as perceived by system actor) | Resource exchange (process, as contributed by system actor) | Value in use (outcome, as perceived by system actor) |
|---|---|---|---|---|
| Social media (e.g., Facebook) | Service user | Social connectedness | Personal and behavioral data | Socially connected, informed and entertained |
| | Service provider | Monetize personal and behavioral data | Social network platform of critical mass | Extensive data about user base |
| | Data customer | Monetize insight from data analytics | Monetary payment/ cost<br>Data | A deep understanding of service user base for personalized value propositions and marketing |
| Web applications (e.g., Google) | Service user | Information seeking<br>Digital collaboration platform | Personal and behavioral data | Experience of digital interactions as a basic commodity |
| | Service provider | Monetize targeted advertising by tracing and understanding human behavior | Maintaining physical/ virtual ecosystem and brand | In depth understanding of human behavior for personalized value propositions and marketing |
| | Data customer | Context-specific understanding of human behavior and sentiment | Monetary payment | Targeted advertising, increased revenues |
| Smart service (e.g., Car Insurance Allstate) | Service user | Perceived greater influence over insurance premiums through gamification-like approach | Driving with sensing device; conscious sharing of behavioral data (e.g., breaking or acceleration) | Potentially reduced insurance premiums and reduced risk for accidents |
| | Service provider | Opportunity to obtain traffic and behavioral data | Development of tracking device and related IT infrastructure | Dynamic pricing model (depending on driver performance) |
| | Data customer | Increased operational efficiency<br>Higher revenues/ reduced cost | Payment (if external) | Increased revenues |

in any data-driven service systems is always contingent on service customers either knowingly (i.e., in the case of a social networking site), or subconsciously (i.e., in the case of a car insurance sensor application), providing personal and behavioral data during resource exchange in human-to-machine contexts.

By developing, maintaining, and providing resources like digital service platforms (e.g., Facebook's social network), web applications (e.g., Google search, Google Docs, Youtube), or smart service systems (e.g., Allstate insurance), service

providers can collect a variety of personal and behavioral data from their customers. The value proposition for these actors is rooted in the ability to monetize such data. For example, targeted advertising or the ability to improve service experiences and offerings eventually culminate in larger user bases, and ultimately in increased revenues. The data customer equally aims to benefit from the personal and behavioral customer data, but is an actor that is typically distinct from the service provider. Data customers do not provide a direct value propositions to service customers (e.g., a social networking site), but are only interested in gaining a deep understanding of service customers, and attempt to do so by analyzing, or getting access to, the insights gained from the personal and behavioral data that service customers contribute. The value proposition for data customers is therefore to monetize insights from data analytics, and these actors accomplish this goal by gaining access to the data (e.g., data-as-a-service) or the analysis (e.g., analytics-as-a-service) in exchange for monetary payments. Consequently, Vargo and Lusch's (2016) statement that value cocreation is a multi-actor process is correct, however, in the age of data-driven service, it appears imprecise to assume that this process is centered around a single beneficiary. And it is these blurred boundaries between the value proposition presented to, and perceived by, service customers, service providers, and data customers that ultimately give ground for the emergence of potentially un-ethical implications associated with data-driven service. We discuss some in the following section.

## 29.4 The Ethical Implications of Data-Driven Service

The information systems discipline has explored potential ethical concerns surrounding ICTs in general for some time (e.g., Smith and Hasnas 1999), and also recently begun to initiate a discourse about the ethical implications of big data analytics (e.g., Zuboff 2015). However, exploring prospective ethical implications of emerging technologies like big data analytics is still unchartered territory within the service science domain, which only focused on prospective benefits associated with big data and service to date (e.g., Rust and Huang 2014). We acknowledge that identifying the greater good in our modern and competitive world is not straightforward (Mingers and Walsham 2010), and therefore build on an established definition of business ethics as the "moral rules, codes, or principles which provide guidelines for right and truthful behavior in specific situations" (Lewis 1985, p. 382). As such, our perspective on ethics is deliberately broad, and intentionally silent as to the underlying philosophical position of what is, or is not, ethical. Put differently, we aim to provide some insights into the underlying reasons why ethical dilemmas may arise when big data analytics is used in service systems, but we do not intend to make a judgement as to what may be an appropriate ethical response.

### 29.4.1 Information Value-Networks in Service Systems

Many data-driven service systems exploit individuals because there is a hidden purpose behind a supposedly 'free' value proposition (Martin 2015). This hidden purpose, however, is unknown to many actors within such service systems, and the processes and mechanisms by which data is collected, and subsequently shared (e.g., sold), can create ethical challenges (Zuboff 2015).

First, the vast majority of service customers does not understand what happens to their data after it is collected. The lack of awareness about how personal and behavioral data is analyzed within data-driven service systems is problematic. For one, we argue that each economic actor should be made explicitly aware of the fact that the immediate value proposition (e.g., social connectedness) comes at a non-monetary cost (e.g., in the form of data). It is unethical if service providers lack transparency and keep the real purposes of data extraction and sharing hidden from customers. Specifically, service customers need to be aware of who owns their data and why, as well as the extent to which their data can be used for secondary purposes. We believe it is fair to assume that very few, if any, service customers explicitly read and understand the terms and conditions of digital web services. And while the awareness of the processes underlying data collection is important, service customers should also be able to trust that their service provider fulfils their legal obligations (which can differ from the legislation in a customer's home country), behave predictably (e.g., will not take advantage of big data analytics to unfairly profile them or use personal data in a manner that is harmful), and does not engage in opportunistic behavior, while ensuring the security of their data. In addition, service customers typically have little or no control over how their data is stored, aggregated, or sold to third par-ties (e.g., data customers). Such lack of control immediately raises ethical concerns because in-sights gained from big data analytics might be incorrect, unwanted, or unanticipated.

Second, service providers understand the real intention underlying their value propositions, and also have the technical capabilities and institutional structures to avoid unethical behavior in data-driven service systems, including limiting data sharing with others (e.g., sold to data customers). We already highlighted that most service provider, at best, hide their data sharing practices from service customers in convoluted 'terms-and-conditions', or provide no transparency of the extent to which data will be shared, with whom, and for what purpose. In this context, it is important to recall that big data analytics in service contexts operates within a value network where personal and behavioral customer data is sold to others. Information value networks thus significantly differ from controlled service supply chains (e.g., Breidbach et al. 2015), since the focal service system actor (e.g., service provider), who collected the data in the first place, may only have very limited control over the subsequent access, quality, or aggregation and use of data within the hands of data customers. This is highly problematic because, as data is shared and aggregated, it becomes increasingly difficult to preserve anonymity of actors.

### 29.4.2 Algorithmic Decision-Making in Service Systems

Any data-driven decision that service providers or data customers make, necessarily re-lies on complex statistical and computational methods that, for example, predict the future behavior of service customers based on their previous actions (Newell and Marabelli 2015). However, this process and its outcomes not only impact value cocreation processes, but also have potentially unethical consequences. First, the reliability of available algorithms today is questionable. Big data sets are characterized by their large volume, velocity, variety (McAfee and Brynjolfsson 2012), and unknown veracity (Schroeck et al. 2012). And while advanced algorithms are needed to provide insights from the personal and behavioral data service customers provide, these algorithms aim to predict future behavior of humans using historical and often subjective data. In fact, in most cases, predictions are based upon correlations as opposed to establishing causal effects. Consequently, it is very difficult, if not impossible to fully ensure that appropriate decisions have been made about individual actors' behavior. As such, this gives rise to, for example, racial profiling or other forms of discrimination (e.g., in cases where individuals apply for, and are denied, insurance).

Second, algorithmic decision-making implies that human involvement is missing, which has also implications for the extent to which decisions made can be held accountable. Specifically, algorithmic decision-making in data-driven service systems requires only minimum involvement by human decision makers, which can range from fully-automated (e.g., no human involvement), to partial involvement. However, whenever human involvement is needed, the data (e.g., alternative options) are visualized. And these visualizations typically aim to convey particular messages in 'near-perfect' scenarios, which omit underlying assumptions, limitations, biases, and potential issues pertaining to data quality. Consequently, human decision makers cannot understand how the data was collected, analyzed, or how alternative options have been developed, which implicitly limits a human's ability to interpret the output and, more importantly, blurs the responsibility for decision outcomes. Consequently, decisions made in algorithmic contexts may be unethical or discriminatory, simply because of poor quality data, or in instances where inadequate algorithms are used.

### 29.4.3 Profiling of Economic Actors and Surveillance in Service Systems

Service provider can analyze the behaviors of their customers in order to offer personalized (Rust and Huang 2014) or seamless (Breidbach et al. 2016) service; however, this also implies that these individuals are no longer exposed to all available choices on a market place, and can no longer exert their basic rights of free choice. Unconstrained big data analytics in service systems and the intentional

or unintentional profiling of individuals results in the classification of individuals into groups based on race, ethnicity, gender, or social and economic status. This may result in discrimination, for example by restricting access to service to some individuals in a service system (Martin 2015), but can also lead to what Zuboff (2015) describes as "surveillance capitalism." The resulting ethical concerns for society at large challenge the fundamental premise of free markets and freedom of choice. Put differently, how can individuals be free if they are under the control of algorithms aiming to influence their decisions (Zuboff 2015)?

On the most basic level, any data-driven monitoring, profiling, or measurement of individual actions and behavior in service systems is a type of surveillance. This necessarily results in a loss of privacy and leads to regulated behavior. The increased digitization of everyday life in western nations through social media, Internet applications, but also cloud computing or the 'Internet-of-things' almost instantaneously enabled service provider to monetize everyday actions and behavior. Such a surveillance society also implies that economic actors are only ex-posed to highly personalized value propositions, but that these are necessarily limited choices because they are developed based on past behavior, location, age, gender, and so on. The out-come is an immediate loss of freedom of choice, as well as uncompetitive and constrained markets or even political discourses. Other potentially negative consequences may include economic discrimination through dynamic and personalized pricing that is not driven by market forces, but by wealth or previous levels of price sensitivity of individuals. The behavior of humans in such service systems is therefore highly regulated, rather than free; especially when compared to 'traditional' markets that displayed information asymmetries. Finally, it is also important to acknowledge that the profiling of individuals in such a surveillance capitalism may simply be incorrect or technically flawed. Digital profiles created by human actors on, for example, social media may not be a true representation of that individual, and aggregated data from various sources may be of poor quality or incomplete; all of which can lead to incorrect analytic outcomes.

## 29.5 Discussion and Conclusions

Big data analytics is a complex socio-technical phenomenon that embodies an inherent duality. For one, big data analytics clearly offers opportunities to advance society through service innovations (Breidbach and Maglio 2015), new business models (Mayer-Schönberger and Cukier 2013), improved healthcare (Murdoch and Detsky 2013), or highly personalized customer service experiences (Rust and Huang 2014). At the same time, its unconstrained, incorrect, or un-regulated use can be disruptive and culminate in unethical consequences for service system ac-tors. Our present work aimed to initiate a new, and significantly more critical discourse in the service science community, which predominantly focused on prospective benefits associated with big data analytics. As such, we addressed current research priorities that called to explore the implications of big data for service (e.g., Ostrom et al.

2015), as we approached the topic from a managerial rather than technical viewpoint (McAfee and Brynjolfsson 2012). Specifically, our chapter provides the necessary terminology and insights to ignite a more informed dis-course that explicitly confronts the ethical consequences that may arise from big data analytics for service systems at large.

For one, this chapter can increase the awareness of service providers about the extent to which unethical challenges can, even inadvertently, arise when big data analytics is introduced into service systems. We are fully aware of the competitive pressure managers face from stake-holders and investors today, and we do therefore understand that using big data analytics to create monetary benefits for their organizations is a highly promising and popular approach many will want to take. In fact, big data analytics led to the emergence of new revenue models like analytics-as-a-service or data-as-a-service, which unequivocally provide incredibly strong incentives to extract even more data from customers. However, we also anticipate that such an unconstrained approach to (big) data collection will eventually hurt the reputation of service firms. It is likely that the awareness of the possibilities and implications of big data analytics will likely in-crease throughout society in the years to come. Consequently, service firms known for their ethical practices and appropriate use of big data may, in fact, gain competitive advantages. Put differently, we anticipate that the reputation of service firms and their level of customer engagement may increase, not despite, but because big data analytics is used ethically. Voluntarily limiting and avoiding certain unethical types of analyses that may could, in fact, be advantageous in the years to come. Establishing such an ethical big data culture may also promote appropriate behavior internally (e.g., within the workforce), but also externally (e.g., within industry associations or stakeholders). Ultimately, the immediate practices related to big data analytics by service providers today will inform future norms, beliefs, and actions. However, future research will need to explore if an ethical big data culture can ideally be achieved through formal policies, standards, or sanctions that punish inappropriate actions.

Second, this chapter also aims to increase the awareness of service customers and society at large about the extent to which ethical problems can arise from big data analytics in service systems. Specifically, while service providers may be driven towards unethical uses of big data analytics due to competitive pressures, service customers are also increasingly pressured to give up their personal and behavioral data in a variety of service contexts if they intend to maintain their participation in modern society. Increasing levels of coercion arise because service providers and peers incentivize us to use apps or social networks. A service customer’s decision to contribute personal or behavioral data is therefore not entirely driven by their free will in every instance, but by the need to engage in economic exchange and value creation. And while this ability to participate in society at large is becoming more and more dependent on using data-driven services, it is evident that our awareness of big data analytics is currently lagging behind. We therefore call for future researchers to better inform potentially vulnerable members of society (e.g., the elderly) about the need to be educated about big data analytics; what it is, how it operates, and what its implications can be. This could, for example, take place

through data literacy programs in the community, or participation in, and influence of, government policies, regulations, and laws that can protect society from potentially big data applications and practices. Finally, we strongly highlight the need to avoid a potential future data-driven power imbalance, where only very few economic actors have access to big data and its analytic insights. Without a democratization of big data analytics, these economic actors could create knowledge asymmetries, which would enable a small minority to gain economic or political power and control over the rest of the population.

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# Chapter 30
# Service-Dominant Logic: Inward and Outward Views

**Luigi Cantone, Pierpaolo Testa, and Teresa Marrone**

**Abstract** This chapter proposes an inward look at Service-Dominant Logic (SDL), exploring the latent theoretical constructs underlying the paradigm. It also takes an outward look at Service-Dominant Logic in management literature, reviewing the major criticism of Lusch and Vargo's pre-theoretical paradigm in an attempt to contribute to a better definition of the boundary conditions under which SDL is applicable or not. The research design is innovative because it adopts a text mining methodology based on literature discussing SDL up to 2014 and also leverages on the authors' speculative reflections on the latest criticism of SDL with a view to concretely advancing the theory. The originality of this chapter lies in the research design aimed to overcome main ambiguity in the theoretical positioning of SDL in marketing literature. The emphasis of the chapter is mainly theoretical, so the implications at management level may be only incidental for the time being.

**Keywords** Service dominant logic · Service logic · Service theory · Service science · Marketing theory

## 30.1 Introduction

SDL has long been a subject of debate around the development of a new general theory of marketing and, more broadly, the market, and the cocreation of value. Several scholars have assessed the impact of Vargo and Lusch's (2004) seminal paper in the marketing and service marketing literature; the paper in fact received the Harold H. Maynard Award for the greatest contribution to the advancement of marketing theory and thought. In addition, it was the most-cited article in the Journal

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_30

of Marketing over the 2000–2009 decade, and counted over 3370 citations over a nine-year period (2004–2013), ranking all-time third among all academic articles on marketing. Kunz and Hogreve (2011), on the basis of a quantitative research on service marketing article citations, quote it as being among the most influential (ranking 12th) service-related publications over the period 1992–2009 in terms of its "prospect factor" (the potential expected influence of the article over the subsequent period). The 2007 article by Lusch et al. is ranked third (2.00) for "Multichannel Customer Management" (4.98) and "Analysis of customer retention and churn rates" (3.19).

The importance of Lusch and Vargo's contributions (Lusch and Vargo 2006, 2011, 2014; Vargo and Lusch 2004, 2008a, 2012; Vargo 2009, 2011; Vargo et al. 2010a, b; Lusch and Nambisan 2014; Lusch et al. 2007, 2008; Vargo and Lusch 2014) is also due to their successful positioning in literature based on how it contrasts with Good Dominant Logic (GDL). Over the last decade, scholars have pursued a continuous process of thinking, refining and clarifying the main tenets of SDL, and thus maintain a high level of interest in the topic. In effect, the founders of SDL have launched and/or participated in several calls for collaboration in the scientific community, including forums to further examine and discuss the potentialities of this dominant new open source paradigm. The long-term effects of participation have generated strong interest in the topic and an increase in citation performance.

This chapter aims to contribute to the debate, analyzing the distinctive contribution of SDL in such a way as to inform the development of a new theory of marketing, market, and value cocreation. The research design employed here is innovative, as it permits a more systematic way of looking at the SDL paradigm from inside and outside, together with the evolution of its adoption patterns in the marketing literature. We combine the analytical depth of text mining methodology with our speculative reflections in order to zoom out from a highly structured understanding of the SDL's distinctive contribution to the development of a new general theory for marketing and, more broadly, for the market and value cocreation process. In coupling this zooming out and our speculative reflections, we seek to identify some general implications to make service logic more useful for marketing managers and enhance marketing and value cocreation in managerial practice. In a recent paper, Vargo and Lusch (2016) underline the urgent need to develop the SDL framework: "S-D Logic can continue to advance over the next decade by moving toward further development of a general theory of the market and, even more broadly, to general theory of value cocreation" (p. 2).

## 30.2 Research Design and Methodology

A number of authors (Van Mele 2006; Nicolini 2009; Leroy et al. 2013), have emphasized the benefits of the "zoom in" and "zoom out" approach to examining phenomena of interest to organizational studies "through switching theoretical lenses and repositioning in the field" (Nicolini 2009, p. 1) to enhance understanding.

Continuing this line of thought, the research questions presented in this chapter are the following: (1) What are the latent theoretical constructs of SDL and their evolutionary pattern (zooming in)? and (2) What are the significantly differential contributions of SDL to the development of a new general theory for marketing and, even more broadly, for value cocreation (zooming out)?

The decade from 2004 to 2014 saw an intense and copious stream of publications on SDL topics. To date, however, this study is the only one to focus specifically on the advancement of the theoretical contribution of SDL to marketing theory using a systematic and analytical approach to gain an understanding of its complexity and its latent constructs. Very few literature reviews have been carried out using statistical text mining techniques. This study also represents an outward-looking examination of Service-Dominant Logic, as it reviews the major criticism (to name but a few: Achrol and Kotler 2006; O'Shaughnessy and O'Shaughnessy 2009; Campbell et al. 2013) in the management literature on Lusch and Vargo's pre-theoretical paradigm. We attempt to answer the criticism from the standpoint of a recent, and broader, formulation of service thinking (Maglio and Spohrer 2008; Vargo and Akaka 2009; Grönroos and Gummerus 2014). At the same time, we contribute to understanding the boundary conditions under which SDL may be applicable or not (Wright and Russell 2012). In conclusion, our study aims to propose further theoretical routes to contribute to the configuration of SDL as a normative mainstream theory.

The research design of this chapter adopts a text mining methodology to zoom in on the latent theoretical constructs underpinning SDL. Statistical text mining software provides sharper focus and a finer understanding of the specifics of the theoretical paradigm and its evolutionary patterns. The research approach adopted is both qualitative (Sawhney et al. 2004; Gummesson 2005; Spanjaard and Freeman 2006a, b; Cantone and Testa 2010, 2011), working on qualitative (using sentences from a literature text corpus) and statistical data, as it employs a statistical text mining technique, in order to reduce the interpretive subjectivity of the analysts. The text mining software explores the literature on SDL over a long period of time (2004–2014) in order to classify and analyze the literature in question as a single corpus using k-means cluster analysis on a multidimensional scaling (MDS) chart. Seventy-eight texts were collected, including papers, working papers, and review papers on SDL published from 2004 (when Vargo and Lusch wrote their first seminal paper on SDL). Of the 78 articles, 12 are contributions by Vargo and Lusch themselves. The corpus was analyzed using the text-mining technique and software—an established social science research methodology—in order to identify interesting patterns and relationships in textual data (Feldman and Sanger 2007; Lancia 2004), and a powerful cluster analysis procedure was performed to represent the contents of the corpus by means of a few significant thematic clusters. The clusters were positioned along latent semantic axes, described according to the lexical units that characterize the sentences found in the literature submitted for analysis. Our speculative reflections on the theoretical repertoires enable us to zoom out onto the distinctive contributions of SDL to the advancement of marketing and value cocreation theory.

## 30.3 Theoretical Background

### *30.3.1 An inward look at the SDL paradigm*

In 2004, Vargo and Lusch believed "that the new perspectives are converging to form a new dominant logic for marketing, one in which service provision rather than goods is fundamental to economic exchange" (p. 1). This is diametrically opposed to the marketing management school known as Goods Dominant Logic (GDL), founded in 1950 (Drucker 1954; McCarthy 1960; Levitt 1960; McKitterick 1957) that traditionally leverages on the marketing mix process, the "4Ps" model (Kotler 1967, 1972).

In GDL (Plé and Chumpitaz Cáceres 2010), value can be seen as a two-stage sequence (Grönroos 2006; Vargo and Lusch 2008a, b). First, the firm creates value during the production process, then the consumer destroys it during the consumption stage. GDL argues that value creation and value destruction are separate and unilateral, that is, they are not interactive. Conversely, SDL implies that value is always coproduced and the provision of service is relational. Marketing has shifted from a goods-dominant view, where tangible and discrete output and transactions are central, to a service-dominant view (Vargo and Lusch 2004), where intangibility, exchange processes, and relationships dominate. In line with both Gummesson (1998a, b) and Grönroos (2000), Vargo and Lusch (2004), extend the logic that a firm can only offer value propositions. The consumer must determine the value and cocreate it, interactively participating in the value cocreation process. Grönroos and Gummerus (2014) do not agree that the firm can only offer value propositions and have developed Service Logic (SL) as a critical feature of SDL: "Because the actors' processes – the firm's service provider and the customer's consumption and value creation processes – merge in one collaborative, dialogical process during direct interactions, a platform for co-creation of value for both actors arises. The activities on this platform are interactive, mutual and reciprocal. Both parties can directly and actively influence each other's processes. Therefore, the value-in-use created for the customer (or the firm or both actors) is influenced by actions that occur on the platform" (p. 220). A number of SL principles for marketing clarify some overlapping of terms such as value, value creation, and cocreation (Grönroos and Gummerus 2014, p. 209), "Value generation is a process that includes actions by several actors – service provider, customer and others – and that ultimately leads to value for the customer. [. . .] Value is defined as value-in-use. For the sake of logical consistency, no other value concept is used. Value-in-use is the value for customers, created by them during their usage of resources. [. . .] Potential value-in-use is the potential value for customers embedded in the resources offered by a service provider. Potential value-in-use is realized as real value (i.e. as value-in-use) for the customer during usage. [. . .] Value creation is the customer's process of extracting value from the usage of resources. Value creation is the customer's creation of value-in-use. [. . .]Co-creation is the process of creating something

together in a process of direct interactions between two or more actors, where the actors' processes merge into one collaborative, dialogical process".

Vargo et al. (2008, p. 150) proposed the concept of value-in-context to explicate this contextual nature of value-in-use and argue that "The context of value creation is as important to the creation of value as the competences of participating parties". So the value is determined contextually and phenomenologically (Vargo and Lusch 2008a, b; Vargo and Lusch 2011; Vargo et al. 2008; Vargo et al. 2010a, b). Akaka and Vargo (2014) argued that value-in-context is always determined by the beneficiary of a service, using particular resources in a specific context. Thus, any given resource has a different value in relation to the different actors, or the same actors in the different contexts where it is used or employed (e.g., time, place, social surroundings) (Akaka and Chandler 2010). In addition, "value co-creation removes the roles of firms as 'producers' and customers as 'consumers' of value" (Akaka and Vargo 2014, p. 5). From this point of view, all economic and social actors are integrators of resources, service providers, and recipients, but they contribute to the creation of value and are responsible for the quality of the service (Berry et al. 1994), fulfilling the guarantees of service (Hart 1988; Akaka and Vargo 2014). Some studies of value-in-context try to explore how customer networks and configurations of relationships involving various stakeholders (Akaka et al. 2012; Chandler and Vargo 2011) influence the value created through service-for-service exchange. In particular, Edvardsson et al. (2011) show how social contexts influence, and are influenced by, interaction in markets (Akaka et al. 2013a, b). Chandler and Vargo (2011, pp. 43–44) propose a multilevel approach to conceptualizing context. The context is composed of: a) a micro level or a framing exchange among individuals as dyads, consisting of two actors and the service-for-service exchange between them; b). a meso level or a framing exchange among dyads as triads, which consist of the indirect service-for-service exchange between two actors by serving the same customer, not only directly in a relationship with him or her; c). a macro level or a framing exchange among triads as ecosystems, as a complex network in which actors, dyads, and triads create synergy among multiple simultaneous direct and indirect service-for-service exchanges; d). a meta-layer level framing exchange among complex networks as an overall service ecosystem. This view of value-in-context emphasizes the recursive nature of value cocreation in service ecosystems. In this view, as actors interact to cocreate value for themselves and for others, they not only contribute to individual levels of experience but also contribute to the formation or contextualization of value in the social context. The social context comprises several interconnected relationships (Chandler and Vargo 2011) and social norms or "institutions" that also guide interaction (Edvardsson et al. 2011; Lusch and Vargo 2011, 2014; Vargo and Akaka 2012; Edvardsson et al. 2014); critiquing Service Logic (Grönroos and Gummerus 2014, p. 209), "value-in-exchange is the potential value embedded in resources provided by a firm, which, through sales, is realized as real value for the firm. Value-in-exchange is a firm-centric concept, based on labour theory, so it is not used in SL".

Using Constantin and Lusch's (1994) definition, Vargo and Lusch (2004) clarify the different contributions of operant and operand resources to marketing activities.

Operand resources, such as knowledge, skills, and expertise, are resources on which an operation or act is performed to produce an effect (Vargo and Lusch 2004), whereas operant resources act on operand resources (and other operant resources). Customer and service provider resources can be categorized as either operant or operand. In the context of Consumer Culture Theory (Arnould et al. 2006), a customer's operant resources are social (network relationships), cultural (specialized knowledge/skills, history, imagination), and physical. In a goods-centered dominant logic, customers, like resources, became something to be captured or acted on ("segmenting", "penetrating", and "promoting to", the market), in the hope of attracting customers. The share of operand resources and the share of (an operand) market were thus the key to success. The relative role of operant resources began to shift in the late 20th century thanks to the work of Zimmerman (1951), Penrose (1959), and Hunt (2002).

Lusch et al. (2008) develop a further ten (initially eight) foundational premises (FPs) of SDL, also taking into account the contribution of the scientific community in terms of suggestions for further evolution. Lusch and Vargo (2006) advocate collaboration between the firm (and relevant partners) and the customer, allowing for a strategic orientation informing the more tactical "4Ps". "Products" are therefore the service flows directly or indirectly provided through an object, "Promotion" is reoriented toward conversation and dialogue with the customer, "Price" is the value proposition created by both sides of the exchange, and "Place" is the value network and process.

Lusch et al. (2007) extend SDL rationale to the competitive advantage of a firm, addressing nine propositions based on the FPs of SDL. In Vargo and Lusch 2008, Vargo and Lusch affirmed once again that there was some lexical confusion due to the elaboration of the SDL paradigm by scholars of GDL, mainly clarifying that "SDL of marketing" puts forward an experiential/phenomenological understanding of value. In addition, they argue that SDL is naturally coherent with social marketing and ethical issues, and societal issues and non-profit marketing in general. SDL is "a mindset, a lens through which to look at social and economic exchange phenomena so they can potentially be seen more clearly" (p. 9). Hunt (Hunt 2002; Hunt and Derozier 2004), however, argues that SDL is not a theory (law-like generalizations, ability to both explain and predict).

Vargo (2009) proposes and elaborates a new SDL conceptualization of relationship that transcends traditional ones. Cocreation and service exchange imply a necessary value-creating relationship or, more precisely, "a complex web of value-creating relationships [. . .]. In particular contexts, optimal (for the firm), normative relationships might include repeat patronage (i.e. multiple, relatively discreet transactions)" (p. 375).

Merz et al. (2009, p. 338) argue that "the preceding review of the branding literature of the past several decades suggests that the branding literature has evolved away from a brand logic that viewed brands as identifiers and embedded in goods and brand value as determined through value-in-exchange to a new brand logic that views brands as dynamic and social processes and brand value as a brand's perceived value-in-use determined by all stakeholders. Moreover, the preceding

discussions demonstrate that the new evolving brand logic parallels and reflects the new evolving service-dominant logic in marketing". In SDL, brand value (Ballantyne and Aitken 2007; Fyrberg and Jüriado 2009) is cocreated together with all the stakeholders and, at the same time, determined by the value collectively perceived by the stakeholders in their own lives. Some SDL-inspired contributions examining the supply chain or buyer-seller relationships were published in 2010. In the past, different terms were used to debate the active role of the consumer in branding in the academic literature. With their contribution on "working consumers", Cova and Dalli (2009) identified several emergent research topics: consumption experience (Carù and Cova 2007; Pine and Gilmore 1999), coproduction in the service encounter (Moore et al. 2005; Rosenbaum and Massiah 2007), consumer resistance (Peñaloza and Price 1993; Ozanne and Murray 1995), collaborative innovation (Von Hippel 1986, 2005; Franke et al. 2006), consumer empowerment (Denegri-Knott et al. 2006; Wathieu et al. 2002), consumer agency (Arnould 2005; Kozinets et al. 2004), and consumer tribes (Cova and Cova 2002; Bagozzi and Dholakia 2006).

Randall et al. (2010) defined performance-based logistics (PBL) as a strategy for improving performance and lowering costs to sustain complex systems (e.g., passenger aircraft, defense systems, and high-speed rail) during the postproduction phase of their life cycle. PBL is a reshaping of the business model based on MRO (maintenance, repair, operation), and this mode of contracting is starting to re-shape how MRO service contracts are drawn up. In essence, PBL is about contracting for performance, rather than tasks or input from the service provider.[1]

Customer dominant logic (CD logic) recognizes that value is not created but formed. "The CD logic extends the scope of value-in-use to a longitudinal experience perspective stressing value as part of the customer's dynamic and multi-framed reality, i.e. value-in-experience. This reality recognises value before, during and after customer experiences as part of the customers' cumulated life and reality. The CD logic reframes value in terms of temporal, situational and cumulative aspects" (Heinonen et al. 2013, p. 7). Experimental marketing theories have been enriched (Schembri 2006) by recognizing not only extraordinary and special experiences but also daily and routine experiences (Schmitt 1999; Korkman 2006; Heinonen et al. 2010). "Value is relative on multiple levels and cumulated and formed in a process related to multiple personal and service related value frames. The customer consciously or unconsciously relates an experience to her cumulated reality and ecosystem at a specific moment, in a specific situation" (Heinonen et al. 2013, p. 8). The customer is considered a beneficiary, a cocreator (Vargo and Lusch 2008a), an actor (Vargo and Lusch 2010), and a part of a network. "The personal nature of value is emphasised recognising the multi-subjective nature of value" (Heinonen et al. 2013, p. 8). Customer experience is not isolated but is dynamic, co-built and non-dualistic (Schembri 2006; Helkkula et al. 2012). "The reality of the customer is

[1]For example, in the case of Rolls Royce, the remuneration of the service provided to maintain engines is defined by the hours the engine is "in the air", a concept known as "power by the hour".

interconnected to the reality of family members, friends, acquaintances, co-workers, strangers etc. at multiple different levels and within multiple different roles" (Heinonen et al. 2013, p. 8). "Although the customer would physically be alone in the customer experience, the experience is always influenced by the customer's internal and external context, i.e. value-in-life. Value is extended beyond the individual and her subjectivity recognizing value as part of a collective social context" (Heinonen et al. 2013, p. 8). The value unit and criteria may evolve from individual to collective and be influenced by different roles (Lepak et al. 2007; Vargo and Lusch 2010; Helkkula et al. 2012). From this standpoint, value is incorporated in the dynamic, collective, and shared reality of the customer. "What we need is not only a network view but a customer-dominant ecosystem view. The primary unit of an ecosystem is the customer, without customers there are no sustainable business ecosystems" (Heinonen et al. 2013, p. 9).

Lüftenegger et al. (2012) propose a canvas model to adapt SDL to business strategy design. The model considers three variables: market relationships, business competences and business resources. Firstly, market relationships answer the question "how do we relate with our business environment in a service dominant business?" (p. 194). Secondly, business competences answer the question "how do we enact our business relations in a service dominant business?" (p. 194). Lastly, business resources answer the question "what ingredients do we need to enact our service dominant strategy?" (p. 195).

Lusch and Nambisan (2014) provide a broadened definition of service innovation as the rebundling of different resources to create new, beneficial ones (i.e., value experiencing) for some of the actors in a given context. It usually involves a network of actors, including the beneficiary (e.g., the customer). The authors propose meta-theoretical foundations for SDL service innovation, namely the service ecosystem, service platforms, and value cocreation.

Actor-to-actor networks imply that service ecosystems are important. Resource density and resource "liquefaction" imply the importance of service platforms, and resource integration implies the importance of the roles and processes underlying value cocreation, bringing the focus onto the mechanisms able to enhance these activities.

#### 30.3.1.1 Findings

The text mining software identifies several sentences fundamental to the meaning of the specific thematic cluster as well as keywords or lemmas (groups of keywords with the same semantic root) very closely related to the specific cluster. Cluster analysis, carried out by the text mining software, identifies macro (semantic axes) and micro (clusters) latent concepts, namely, the underlying SDL's latent (macro and micro) theoretical constructs. To interpret the clusters, we analyzed the sentences that the software identified in the corpus as inherent to the meaning of the specific thematic cluster together with the keywords or lemmas closely related to each cluster. Table 30.1 in the Appendix shows the main findings of the analysis.

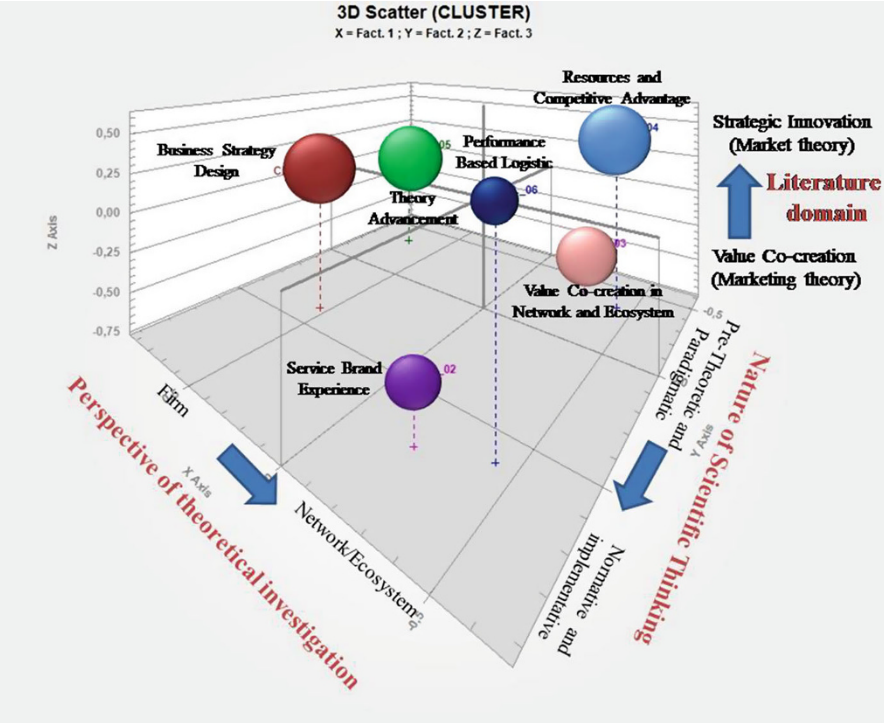


Fig. 30.1 The macro and micro latent theoretical constructs of SDL

Cluster analysis returned six theoretical repertoires (latent SDL theoretical constructs), also referred to as "thematic clusters", distributed within a three-dimensional graph, as described in Fig. 30.1.

The evidence from the cluster analysis makes it possible to interpret the underlying meaning of the three factors (axes x, y, z) in the map of the cluster (Fig. 30.1). The x-axis is explained positively by clusters 1 (Business Strategy Design) and 5 (Theory Advancement), and negatively by clusters 3 (Value Cocreation in a Network and Ecosystem), 6 (Buyer-Seller Relationships and Performance-Based Logistic), 2 (Service Brand Experience), and 4 (Resources and Competitive Advantage). "Perspective of theoretical investigation" (firm vs. network and ecosystem) is thus the meaning assigned to the x-axis. In fact, SDL, as the positioning of cluster 5 shows, underlines certain points of contrast with GDL, which considers the marketing management model and the marketing mix levers exclusively from the firm's perspective. In recent years, the SDL paradigm has widened its perspective in order to assess the contribution of value cocreation from the point of view of the business network within the service ecosystem as a whole. Resources and competencies (operant and operand resources) are interactions and integrations of tangible and intangible resources in a business network or wide ecosystem, and the SDL and Service Science perspectives explain Buyer-Seller Relationships and Performance-

Based Logistics. In effect, from this new perspective, the buyer-seller relationship is evolving into a network relationship, and SDL is moving beyond the traditional supply-demand and/or buyer-seller distinction so that brand is the value cocreation that arises in a context where several actors experience the firm's value proposition in a social and/or business context.

The y-axis is explained positively by clusters 2 (Service Brand Experience), 6 (Buyer-Seller Relationships-Performance Based Logistic), and 1 (Business Strategy Design) and negatively by clusters 4 (Resources and Competitive Advantage), 5 (Theory Advancement), and 3 (Value Co-creation in Networks and Ecosystem). "Nature of scientific thinking" is thus the meaning attributable to the y-axis. SDL is a pre-theoretical paradigm that can be used to advance marketing theory in preference to GDL. Over time, SDL scholars have examined theoretical aspects such as the role of resources (operant and operand) in competitive advantage and the meaning of network and ecosystem from the point of view of value co-creation and SDL. Due to calls for articles by SDL scholars, the various contributions received in response have allowed the movement to become consolidated into a systemic, cohesive and highly specific context. New research has been carried out on important topics like the customer-brand relationship (Payne et al. 2009) from the SDL perspective. Others have involved Business Strategy Design for exploring Business Model Innovation from the SDL perspective and the arising markets theory perspective. The Buyer-Seller and Performance-Based Logistic relationships topic, on the other hand, explores the modalities whereby seller and buyer may evolve towards new configurations of the service relationship that will allow traditional suppliers to reconfigure their value system in order to internalize some buyers' activities, increase profitability, and create more value for the buyer.

Lastly, the z-axis is positively explained by clusters 6 (Buyer-Seller Relationships and Performance-Based Logistics), 4 (Resources and Competitive Advantage) and 1 (Business Strategy Design), and negatively by clusters 2 (Service Brand Experience), 3 (Value Co-creation in Network and Ecosystem), and 5 (Theory Advancement), so the z-axis takes on the meaning of "Literature domain" In fact, as shown by the positioning of cluster 5, SDL started out as a value co-creation marketing theory. In recent years, the authors have tried to exploit the topic in a different direction, moving the focus towards strategic innovation and a new markets theory. In fact, the Buyer-Seller Relationships and Performance-Based Logistics mainly relate to Service Model Design in industrial relationships, geared toward competitive advantage and win-win performance in the network ecosystem, in relations traditionally defined as buyer-seller relationships. Indeed, the topic is theoretically much more consistent with the Business Model Design than with Network Relationships. Like Business Strategy Design, the topic of Buyer-Seller Relationships and Performance-Based Logistics is related to the definition of the business equation in new venture initiatives. Resources and competencies are the enabling resources that permit the business network and/or the overall ecosystem to achieve strategic innovation. Recently in fact, SDL scholars have published a number of contributions and launched calls to achieve a new definition of "market theory" (Chandler and Vargo 2011; Vargo 2011). The same recent contributions on Service Innovation

(Ordanini and Parasuraman 2011) are coherent with this perspective. Ultimately, it is clear that in recent years, the SDL paradigm has highlighted an evolutionary pattern marked by: a) shifting the nature of thinking from pre-theoretic to normative, b) shifting the perspective from the firm to the network and ecosystem, and c) shifting the literature domain from value cocreation to strategic innovation and defining market theory.

### *30.3.2 Looking outward from the SDL paradigm*

#### 30.3.2.1 Service Science

Maglio and Spohrer (2008) recognized SDL (Vargo and Lusch 2004; Lusch et al. 2008; Vargo et al. 2010a) as a potential philosophical foundation for "service science", which is an interdisciplinary field that "combines organization and human understanding with business and technological understanding to categorize and explain the many types of service systems that exist as well as how service systems interact and evolve to co-create value" (Maglio and Spohrer 2008, p. 18). Service systems are "value co-creation configurations of people, technology, and value propositions connecting internal and external service systems and shared information" (p. 18).

Service science is the study of service system entities and value cocreation mechanisms, the term being a shortened form of Service Science, Management, Engineering, and Design, also known as SSMED. Service science aims to explain and improve interactions in which multiple entities work together to achieve win-win outcomes or mutual benefits (Spohrer and Maglio 2008; Spohrer and Maglio 2010a, b). Service is value cocreation, and Service Phenomena (Spohrer and Maglio 2010a, b) occur when entities interact according to pre-defined mechanisms that (normatively) result in value cocreation outcomes (win-win or benefit-benefit interactions).

Gummesson (2007) suggested that from a provider perspective, the word offerings can replace both goods and services, and along with Vargo and Lusch (2004), noted that service (in the singular) is the core concept underlying both goods and services. "A supplier offers a value proposition, but value actualisation occurs in the usage and consumption process. Thus, value is the outcome of cocreation interactions between suppliers and customers" (p. 5). Gummesson advocated going beyond the customer-provider dyad to consider complex adaptive networks of customer-provider entities and their different offerings and actualisations.

Service "arises naturally in the context of distinct entities, such as people, businesses, and nations, that have information processing and communication capabilities as well as distinct resource-based capabilities. These different entities opportunistically and systematically interact to realize mutually beneficial outcomes. Simply put, service phenomena arise in a real-world ecology of entities, their

interactions, and their capacity for finding mutually beneficial outcomes" (Maglio and Spohrer 2013, p. 2).

According to Vargo and Lusch (2004), the four prototypical characteristics often believed to distinguish services from goods, namely intangibility, inseparability, heterogeneity, and perishability do not distinguish services from goods at all, and only have meaning from a manufacturing perspective. What is more, they imply inappropriate normative strategies (Alter 2012). "Natural sciences explain the origin and evolution of natural things. Artificial sciences explain artificial things, things designed by humans to serve a human purpose. Value cocreation is a human purpose. Service science is value cocreation science, and studies service system entity structures and their interaction mechanisms. Service science as a specialization of systems science attempts to integrate elements of many disciplines and systems around the theme of value cocreation" (Spohrer and Maglio 2010a, b, p. 187).

Service systems are value-cocreation configurations of people, technology, value propositions connecting internal and external service systems as well as shared information (e.g., language, laws, measures, and methods). As argued by Slimani (2013, p. 18), "service is the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself (Vargo and Lusch 2004, p. 2) and depends on division of labor and effective cocreation of value, leading to complementary specialization and comparative advantage among participants" (Normann 2001).

"Over time, routine work (e.g., productivity and basic quality levels) tends to migrate into enhanced technological capabilities of providers (through use of automation) and customers (through use of self-service technology), and non-routine work (e.g., innovation and governance) tends to migrate into enhanced human capabilities of providers (such as entrepreneurs) and customers (e.g., self-governance requires informed citizenry)" (Maglio and Spohrer 2013, p. 667). Today, the more knowledge-intensive and customized the service, the more it depends on client participation and input, either through customers providing labor, property, or information (Sampson and Froehle 2006).

Maglio and Spohrer (2013) described four basic principles for service science:

1. First principle of service science: service system entities dynamically configure four types of resources: people, technologies, organizations, and information.
2. Second principle of service science: service system entities compute value according to the concerns of multiple stakeholders.

   Facebook, LinkedIn, and other social network service providers have business models that depend on the nature of access to shared and proprietary information resources.
3. Third principle of service science: the access rights associated with customer and provider resources are reconfigured by mutually agreed upon value propositions. Value cocreation depends on the coordination of activities across individuals, organizations, and firms, often in intimate relationships that involve sharing resources, risks, and rewards. Coordination of action across a network depends

on information flow. Improvements in valuing processes are symbolic processes that can be shared and agreed on by service system entities.

4. Fourth principle of service science: Service system entities compute and coordinate actions with others through symbolic processes of valuing and symbolic processes of communicating.

In combination, the above quotations and other parts of the service science literature, such as IfM and IBM (2008), seem to say that service science is a general umbrella that covers (Alter 2012):

- things ranging from totally automated computer-to-computer interactions (e.g., client/server computing and service-oriented architectures) to personal services produced by providers for customers through direct person-to-person interaction (e.g., tutoring and physical therapy)
- things ranging from locally situated service activities (queuing systems in banks and grocery stores) through gigantic service systems such as entire governments, water and electricity systems, international monetary systems, and systems for policing large populations
- things ranging from the classification of industrial enterprises (such as service, industrial, or agricultural) through the operational details of specific service systems within organizations that produce services and/or industrial or agricultural products.

## Major Criticisms of the SDL Paradigm

Achrol and Kotler (2006, p. 329), argue, "the distinction between operand and operant resources is not important ontologically. In theory, no resource is inherently operand or operant; it is only a function of the level of explanation and the role (explananda or explanandum) that the variable (resource) plays in the theoretical scheme. Labor and capital are both operand and operant resources. So are knowledge and information. When resources are created or acquired, they are operands. When they are applied to a problem, they are operant".

Campbell et al. (2013, p. 310) took similar issue: "We thus come to a critical realization; the operant (knowledge, skills, mental life, information) is only available within and through the operand (material life), and the type and quality of operant is dependent on the type and quality of operand resource in which it is embedded. [. . .] The operand therefore sets the possibilities and the limits of the operant. Thus, any theory of service must theorize the bodies that perform service work, the material objects used to deliver it, and the material that it generates, three areas on which we elaborate". They advocate considering operant and operand resources as coevolving interdependently, so organizations can re-visit operand resources in a new light, not merely as something static, but as intelligent entities whose properties are not always "worked on" but followed by humans.

O'Shaughnessy and O'Shaughnessy (2009) moved a strong criticism toward SDL. Lusch and Vargo (2011, p. 1299) summarized the core points of their

colleagues' article as follows: S-D logic "[...] is neither logically sound nor a perspective to displace others in marketing" (p. 784) reflects an "[...] indifference to theoretical considerations" (p. 784), has had a "considerable impact among marketing scholars, particularly in the USA" (p. 785), its promotion "as the single best perspective for marketing is regressive" (p. 785), and it represents a "wrong-headed advocacy of technology at the expense of explanatory theory" (p. 791). Lusch and Vargo (2011), replying to the authors affirmed "We do not believe that S-D logic takes us backward from G-D logic but rather forward, toward more robustness and relevance. Clearly, O'Shaughnessy and O'Shaughnessy (2009) believe otherwise but it is neither for them nor us to decide. Only the discipline as a whole can decide and it will be up to the historians of marketing science far in the future to tell the complete story" (p. 1307).

Leroy et al. (2013, pp. 1109–1110) affirm that, "With the abstraction approach of zooming out advocated by Vargo and Lusch (2011) by way of the concept of value co-creation, there exists a risk of premature black-boxization of the concept; however, we believe the controversy on the subject to be far from over. By showing how the levels of observation and units of analysis adopted by researchers on value co-creation vary, this article sheds light on the current inability of the concept to account for the heterogeneity of the reality of exchanges and, in particular, B2B exchanges. The concept indeed functions more as a metaphor than as a genuine scientific construct". SDL describes value creation and value co-creation at aggregate and metaphorical level (Grönroos and Ravald 2011; Grönroos and Voima 2013), saying nothing about processes or the role of the actors involved in carrying them out. This approach gives no sense of value creation and cocreation from the management perspective (Grönroos and Gummerus 2014). In order to forestall value cocreation black-boxing, they propose a scale for observing reality that will allow any researcher to zoom in and gain a better idea of the level of granularity suited to the inquiry at hand.

Underlining the differences between SDL and Service Logic, Grönroos and Gummerus (2014) argue "The approach we adopt, the SL approach, is managerial in its emphasis and seeks to make the service perspective more useful for managers. It differs from that of the SDL, which instead tends to be geared towards describing the service perspective on an aggregate, societally oriented level" (p. 207).

Ambler (2006) questions, "whether the 'marketing elephant' is changing as consequence of SDL affirmation or whether we are merely seeing the same beast from different points of view" (p. 2). In reviewing the historical development of marketing thinking, Ambler argues that new concepts should be tested for validity as well as increasing shareholder values and adding something new. Conversely, GDL has been tested for over 200 years and validated by marketing managers' success histories. So the Author concludes that "The key to survival in this marketing-hostile ecology is the intangible asset created by good marketing, namely brand equity or reputation [...] So perhaps building brand equity in order to maximize long-term cash flow is the new dominant logic" (p. 9).

Egan (2009) also identified and systemized some weaknesses in SDL. In S-D logic, a relationship with consumers is assumed to exist regardless of whether it is

desired or required. Lessons from the past suggest that any definition of marketing must allow for both relationships and non-relationships (Grönroos 2006). The consumers of goods have limited control over the outcome of their choice (Shankar and Malthouse 2006) and therefore have limited power to create value other than what is offered to them. Abandoning the value creation process in favor of the customer and only accepting responsibility for suggesting what they might achieve as a result of the experience goes a long way to absolving marketers and businesses from any guilt, responsibility or negative consequence of their actions (Shankar and Malthouse 2006). Another perceived weakness of S-D logic is that under its influence the "time logic of marketing becomes open ended, from pre-sale service interaction to post-sale value-in-use, with the prospect of continuing further, as relationships evolve" (Ballantyne and Varey 2006, p. 336). As clarified by Egan (2009), S-D logic considers marketing to have a role at all stages in the process of consumption—including planning, selection, purchase, consumption, and disposal (Flint 2006) ones—but, how many Chief Marketing Officers, in reality, are involved (or care) about all the other activities after purchase?

Collins and Murphy (2009) argue that SDL decentralizes the power of controlling the brand and product experience in favor of consumers. In the world of the Internet and web-based industries, this decentralization is everyday business. The Authors refer to Carse's (1986) metaphor of finite and infinite games: "SDL is an infinite game in that products, brands and corporations evolve organically within market environments and survive or thrive depending on their ability to engage with the consumer (Collins and Murphy 2009, p. 5) [...] The infinite game metaphor leads marketing discussions in a direction toward sustainable engagement (p. 5). [. . .] Marketing is joyful. Connecting with customers is thrilling. Creating value with others is exciting" (p. 6).

#### 30.3.2.2 Evolutionary Steps Towards a Theory of Service

An ecosystem is a community of interacting entities, organizations and individuals (including customers) that coevolve their capabilities and roles and depend on one another for their overall effectiveness and survival (Iansiti and Levien 2004; Lusch and Nambisan 2015). Following S-D logic, the service innovation concept is seen "as being embedded in an A2A network and begin[s] with the notion of service ecosystems, which underscore the importance of common organizational structures and sets of principles to facilitate resource integration and service exchange among those actors" (Lusch and Nambisan 2014, p. 161). Specifically, starting from the ideas and definitions developed by Vargo and Lusch (2011a), Lusch and Nambisan (2014) define the service ecosystem as a relatively self-contained, self-adjusting system of mostly loosely coupled social and economic (resource-integrating) actors connected by shared institutional logics and mutual value creation through service exchange.

"There is a great variety of service systems [and] value cocreation arrangements among distinct entities. As mentioned, a service system entity is a value cocreation

configuration of people, technology, other internal and external service system entities, and shared information. This recursive definition highlights that fact that they have internal structure and external structure in which value is cocreated directly or indirectly with other service system entities. Individuals, families, firms, nations, and economies are all instances of service system entities" (Spohrer and Maglio 2010b, p. 177). S-D logic's ecosystems approach provides a view of value cocreation and innovation that enables oscillation among micro, meso, and macro level perspectives (Chandler and Vargo 2011). According to Vargo et al. (2008), this is important for studying innovation in systems of service-for-service exchange.

Akaka and Vargo (2014) also consider the individuals, groups, organizations, firms, and governments to be service systems as they can take action, apply resources, and work with other actors searching for mutual benefits. Interactions in the ecosystems, including the exchange of resources, appear increasingly complex, and can occur at micro (e.g., dyadic exchange encounter), meso (e.g., organizations), and macro levels (e.g., countries) and need to be closely examined through a number of S-D logic ecosystems lenses (Vargo et al. 2008; Akaka et al. 2012). "Within a service-ecosystems view, what is fundamentally an exchange of service-for-service becomes a complicated web when organizations, monetized exchange and multidimensional interactions are included" (Akaka et al. 2012, p. 19). Furthermore, recent research on service ecosystems extends the basic premises of S-D logic (Lusch and Vargo 2014) and underscores the complexity of the context that frames value creation and exchange (Akaka et al. 2013a, b). For Akaka and Vargo (2015), a service ecosystems approach considers the direct and indirect interactions of multiple actors in value cocreation rather than focusing on the cocreation of value as direct firm/customer interactions (Grönroos and Voima 2013).

It is important to note, however, that taking into account multiple levels of interaction and value creation is not only a matter of networks of relationships, but also involves institutions that guide the actions and interactions of micro, meso, and macro level relationships (Vargo and Lusch 2011).

In order to explain the role of Information Technology (IT) in SDL "we draw on the networks literature and consider three underlying aspects of a service ecosystem: (1) a set of mostly loosely coupled value-proposing social and economic actors who forge relationships with one another for service exchange and the ensuing tension between structural flexibility and structural integrity, (2) the need to maintain shared institutional logics, which allow for a shared worldview among a diverse set of actors with considerable cognitive distance among them, and (3) the need to implement and maintain a common set of rules and principles derived from the shared institutional logics or an architecture of participation in the ecosystem that coordinates actors and their service exchanges" (Lusch and Nambisan 2014, p. 163). [. . .] "However, the actors find that service exchange in a service ecosystem is not very efficient without a service platform which helps to liquefy resources and enhance resource density through efficient and effective service exchange" (Lusch and Nambisan 2014, p. 161).

In summary, the three elements together (service ecosystems, service platforms, and value co-creation) capture all the different concepts and issues underlying the broadened view of service innovation (Akaka and Vargo 2014). Service ecosystems have been defined as “relatively self-contained, self-adjusting system[s] of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” (Lusch and Vargo 2014, p. 161; Vargo and Lusch 2016, pp. 10–11). In this view, the context of service, together with value cocreation, is socially constructed through the exchange (Vargo and Lusch 2011) and application of operant resources (e.g., knowledge and skills) among multiple actors (Akaka and Vargo 2015). In addition to emphasis on service as the basis of exchange and value creation, this view explicates the complex and dynamic nature of the social systems through which service is provided, resources are integrated, and value is cocreated. The study of service ecosystems has begun to explore how service experiences occur within extended networks of interaction and intersecting institutions that influence and are influenced by ongoing efforts to cocreate value (Akaka et al. 2013a, b; Chandler and Lusch 2015; Vargo et al. 2014, Akaka and Vargo 2015).

Vargo and Akaka (2012) argue that the S-D logic and the service-(eco)systems view are coherent with a number of systems theories (Barile and Polese 2010a, b; Ng et al. 2010) and provide the foundation for the service system as a network of actors that integrate resources and interact with each other to cocreate value (Ng and Smith 2012).

The viability of a system can be expressed and measured in terms of its ability to survive and thrive in its surrounding environment (Vargo et al. 2008; Barile and Polese 2010a, b; Vargo and Akaka 2012). Normann (2001) argues that firms should focus on their ability to break up, or “unbundle” and put together, or “rebundle”, available offerings (Akaka and Vargo 2014). “In this way, value co-creation occurs as a firm unbundles and rebundles, and it enables service beneficiaries to unbundle and/or rebundle their offerings with those from other resource providers. The self-customization and rebundling of resources enhances the customer’s co-created experience and strengthens ties between the relationships among firms and customers” (Vargo and Akaka 2012, p. 212).

SSME (Service Science Management and Engineering), we have seen, is an effort to create a science around breaking down and recomposing service-based processes, optimizing service supply chains and value chains and creating interdisciplinary research centers to design and optimize complex service systems that will be combinations of people, organizational networks, and technologies aligned around a specific objective, such as designing and managing more livable cities, more effective healthcare systems, and more efficient energy networks (McLuhan 2013). Finally, Hietanen et al. (2017), turning back to Marx’s original thought, deeply criticizes the SDL, which, according to them, has determined a commoditization of economic value by betraying the original meaning of the use-value of Marxist theory. They also believe that SDL is not well-equipped to understand consumer culture since each brand and goods incorporates an ideology and a symbolism to identify and distinguish the consumers each others within the society. “Every object

(or market offering) is a distinction in the system, and thus we never simply consume an object in isolation—rather, we consume its signification in relation to the whole commodity market" (Hietanen et al. 2017, p. 9). Conceptualizing "value-in-context" and betraying the original meaning of use-value SDL "has disregarded class antagonisms and the implicit disciplining forces of capitalism" (p. 12).

## 30.4 Discussion

In 2004, Vargo and Lusch proposed a new paradigm of marketing: SDL, running counter to GDL and its foundational concept of marketing mix. The last decade has seen numerous calls for papers in order to move beyond the pre-theoretical narrative of SDL, enabling it to become a dominant theory in marketing and value cocreation. To date, however, SDL is still a pre-theoretical paradigm. In a recent article, Vargo and Lusch (2016, p. 6) have recognized the need to "(1) further update the existing FPs of S-D logic, highlight their consolidation into a smaller set of axioms, and adjust the language, as needed, for consistency, (2) highlight the concept of service ecosystems to identify the role of institutions, (3) briefly review institutional theory in marketing and other social science literatures, (4) explore the role of institutions (and by implication, service ecosystems) in the S-D logic framework, offering a fifth axiom that recognizes the role of institutions in value cocreation, and (5) point toward future directions for S-D logic theory development and research". This then is an ongoing development of SDL thinking on core concepts, some of which have already been debated in the literature analyzed in this chapter.

SDL has contributed to creating greater interest among the international academic community in service as the basis of any business and service-for service exchange as a key perspective of marketing. In addition, resource integration as a key process in value creation and cocreation together with "contextualization of value" through the role of the ecosystem and institutions as units of analysis (Chandler and Vargo 2011; Akaka et al. 2013a, b) are further valuable frameworks and concepts developed by Vargo and Lusch and other scholars with the introduction of the SDL. There is undoubtedly a huge and ongoing debate aiming to rejuvenate the foundational principles of marketing. However, to date, SDL has not yet developed a new general theory of marketing, nor has it spawned a general theory of value cocreation. Indeed, there has been a shortage of empirical investigation into SDL and a lack of execution processes or normative implications for management. SDL falls short of providing a managerial perspective able to make it useful for managers (Grönroos and Gummerus 2014) or the value (co)creation process. Lusch and Vargo (2006) argue that SDL could be the basis from which a new orientation in marketing theory could spring, yet they themselves recent affirm that "this reorientation would not necessitate abandonment of most of the traditional core concepts, such as the marketing mix, target marketing, and market segmentation, but rather it would complement these with a framework based on the eight (subsequently ten) FPs we have discussed" (Lusch and Vargo 2006, p. 23). "Complement" does not equate to

substitute, so "reorientation" toward a new marketing theory will not happen without normative and implementation rules and processes. From the SDL perspective, for example, reorientation involving the tactical "4Ps" of marketing mix remains at the abstract, metaphorical, and aggregate level. "Products" are service flows, objects that directly or indirectly provide the service. "Promotion" is reoriented toward conversation and dialogue with the customer. "Price" is the value proposition created by both sides in the exchange, and "Place" is the value network and processes (Lusch and Vargo 2006).

SDL theory is closer to, rather than far away from, the assumption of the traditional marketing theory that it has tried to leave behind. The latter has proved to be flexible in adapting to some emergent evolutionary concepts such as value creation, value proposition, relationship marketing, value cocreation, and consumer brand experience. It has proven to be evolutionary in its nature, remaining open to adapting to the research stream rather than misaligning with it.

Nevertheless, the evolutionary pattern of SDL has proven to be too ambitious. The creators of SDL themselves have explored research fields outside of marketing, disseminating their contribution to, and implications for, service science, resources and competitive advantage, strategic business design, strategic orientation, market creation, networks, institutions/ecosystem, practice, evolution, and complexity. SDL authors have stressed widening the scope (zooming out) of their thinking rather than deepening its implementation process (zooming in). However, it is quite difficult to imagine only one paradigm as being effective in service marketing, marketing theory, supply chain management, service science, strategic management, and so forth.

Ultimately, our text mining of the SDL literature, zooming in on its latent theoretical constructs and its evolutionary patterns, highlights some critical points. Firstly, using SDL as a broader framework to encompass theories, concepts and frameworks outside the field of marketing has meant failure to focus on the marketing, value creation, and cocreation process, and with it the failure to advance toward developing a new general theory of marketing and value cocreation. SDL has, in our opinion, emphasized the zooming out approach more than the zooming in, though it would have been more appropriate to alternate both approaches in order to understand the value creation and cocreation phenomena (Chandler and Vargo 2011). The result, therefore, is a meta-level theory of value cocreation based on a zooming out research approach that will remain the theoretical orientation in the future, as stated by Vargo and Lusch in a recent paper, arguing for the integration of resources involving several actors in the value co-creation process (Vargo and Lusch 2016, p. 8). "Partly due to the editorial focus of the Journal of Marketing (Vargo and Lusch 2004a), as well as to the latent influence of the traditional model, the initial perspective was relatively dyadic and micro-level focused and somewhat managerially oriented. The next major turn occurred therefore with the attempt to zoom out to reveal the bigger picture. Initially, the zooming out exposed other actors, at first generally seen as other firms (e.g., "competitors" and "suppliers") and the extended to customer connections (e.g., family, peers, etc.), all involved in service-for-service exchange, thus, at least part of the broader context (Akaka et al. 2013b). But closer

examination revealed that all of these actors exhibited foundational commonalities in addition service-to-service exchange—resource integration activities". Secondly, and following on from the previous point, is the lack of emphasis on management that, to date, has meant that the foundational premises (FPs) are not particularly useful in managerial practice. Thirdly, as Grönroos and Gummerus (2014) point out, SDL does not explicitly define the concept of "value", using the term with a variety of meanings, such as value-in-use, value-in-context (Ballantyne and Varey 2006; Grönroos 2008; Vargo and Lusch 2004; Vargo et al. 2008), and value-in-exchange (Zeithaml 1988; Lusch et al. 2007) in different contexts. The authors argue (p. 209) that, from a customer-centric perspective, the key concept of value is value-in-use, and it is always created and determined by the customers, using and integrating their own resources with those provided by the firm.

For Grönroos and Gummerus (2014, p. 209), "the value generation process comprises three value spheres: a provider sphere that is closed to customers, where the service provider compiles resources, including potential value-in-use, to be offered to customers to facilitate their value creation; a joint sphere in which the service provider and customers interact directly, which enables the provider to engage with customers' value creation and cocreate value with them; and a customer sphere, which is closed to the service provider and where the customers independently create value and may socially co-create value with actors in their ecosystem". Grönroos and Voima (2013, p. 140) had already discussed the concept of value creation spheres: "the roles of the firm and customer vary, depending on the value creation sphere. The firm is responsible for the production process (used as a global term for design, development, manufacturing, delivery, backoffice, and front-office processes), and in the provider sphere it produces resources and processes for customers' use. [. . .] In the joint sphere, the role of the customer is twofold: coproducer of resources and processes with the firm and value creator jointly with the firm. In direct interactions with the customer, the firm may have an opportunity to engage with the customer's value creation process and take on the role of value co-creator. In the rest of the customer sphere, which is closed to the provider, the customer creates value as value-in-use independently of the provider. No direct interactions exist and no co-creation takes place". In the customer sphere, value-in-use emerges through the customers' accumulation of experiences with resources, processes, and outcomes in their social, physical, mental, temporal, and spatial contexts. During this phase, customers only interact with their own resources and those obtained from the firm.

In the Customer-Dominant Logic perspective (Heinonen et al. 2010, 2013) the customer creates the value, so the customer sphere is a crucial locus for value creation. The complexity of value creation, and the need to explore it better, is highlighted by recent developments in service research focused on value-in-life and value-in-experience (Heinonen et al. 2013). These two concepts underline that value is not simply created and delivered by the service provider (Grönroos 2006; Gummesson 2007; Heinonen et al. 2013) but is created during the use or experience of customers deploying their resources, integrating them with a firm's resources and offerings. SDL does not clarify the value cocreation process, and does not explicitly

identify the specific role of any actor involved (customers, service providers, others) or how they relate to each other, nor how the process takes place on the "co-creation platform" (Grönroos and Gummerus (2014). According to Grönroos and Gummerus (2014, p. 209), "a co-creation platform is formed when two or more actors' processes – such as a service provider's and a customer's processes – merge into one collaborative, dialogical process, in which the actors actively influence each other's processes and outcomes. A co-creation platform entails only direct interactions".

We believe that, from the customer-centered standpoint, the value cocreation effort, involving firm, customers and other actors, starts with customer engagement (Bowden 2009; Brodie et al. 2011). As Grönroos (2009, p. 353) argues, engagement is the essential mission of marketing: "The goal for marketing is to engage the firm with the customers' processes with an aim to support value creation in those processes, in a mutual beneficiary way". It is also the starting point in the value cocreation process, the core collaborative process in which the actors may directly and actively influence each other in the value cocreation effort. SDL does not define the different levels of customer collaboration in value cocreation. In our opinion, the theoretical perspective of customer engagement is fundamentally different from all the others, which see the customer as cocreator or co-producer of value (Cantone et al. 2015). The cocreation process is actually grounded on an aware and active cooperation between companies, customers and other relevant actors, all of which interact, integrate and apply their resources (skills, knowledge, competencies, experience, products, services, brands, etc.) to cocreate value (Lusch and Vargo 2006; Lusch et al. 2007). To this end, customers determine how their operant-operand resources and service provider's operand-operant resources are employed and integrated to create value for them (Edvardsson et al. 2011; Lusch and Vargo 2014; Vargo and Lusch 2011; Arnould et al. 2006; Baron and Harris 2008). Conversely, customer engagement mainly involves the spontaneous engagement of customers with potential value-in-use embedded in resources made available by a firm. Customer engagement and collaboration work on four direct interaction levels that represent practice spaces in which the actors (companies, customers, other actors) actively and directly participate to cocreate value. At all levels, customers create value for themselves (value-in-use), integrating their own resources with those provided by the firm. From the customer standpoint, the interaction levels are as follows: (1) Production (performance) of the operational activities related to the resources provided by the firm, such as components of actual products (i.e., ready for use product assembling) or services (i.e., product delivering, e-ticketing, etc.) or a mixture of the two (i.e., defining a PC configuration, drawing up a holiday package). (2) Improving the resources provided by the firm, increasing the potential value-in-use for the customer and the value-in-exchange for the firm. (3) Innovating the resources provided by the firm, creating new sources of value-in-use and value-in-exchange. (4) Defining values and meanings associated with the firm's resources (i.e., a brand), an aspect that concerns the deep-rooted cultural (symbols, images, texts, codes, meanings, etc.) and affective (feelings, judgments, personality, history, heritage, experiences, etc.) elements of the resources (i.e., brand equity). Customer collaboration in cocreating value is generally triggered and planned by firms and

takes place at all levels of interaction through specific practices, routines, or processes made available by the firms themselves. The customer, on the other hand, spontaneously promotes engagement that may, but only at a later stage, evolve into collaboration in value cocreation. From a customer-centered perspective (Heinonen et al. 2010, 2013), the need for the customer to be engaged with the resources of a service provider (i.e., the brand) arises from the customer's own context, experience, life, history, culture and multiple social relationships. Therefore, consumers engaged with the resources made available by firms can have a collaborative and cocreative role only when recognized and fostered by the firm, and this can only come about when the right practices/processes and resources to enable cooperation and value cocreation are brought into play.

We believe that service logic research should focus on the engagement-cocreation "platform" (Grönroos and Gummerus 2014), examining how it takes place through its practices, explicitly identifying the specific role of all the actors involved (customers, service providers, other actors) and how they relate to each other on this "platform". This might provide deeper insights into cocreation processes and how the marketing levers deploy them in the value cocreation process, and in so doing perhaps make the service perspective more useful to managers.

As several scholars have noted, the SDL literature still only vaguely addresses (if at all) some essential questions such as how resource integration occurs, what happens during the resource integration process, and what results stem from the resources (Plé 2016; Baron and Warnaby 2011a, b; Edvardsson et al. 2014; Peters 2012a, b; Akaka et al. 2012; Grönroos and Gummerus 2014). From the customer-centered perspective, there is a need to understand how value emerges in the sphere of the customer, and how customers deploy their resources and integrate the provider's resources into the co-creation process (Plé 2016; Heinonen et al. 2013, 2010; Edvardsson et al. 2012).

This research stream needs more empirical studies to validate the theory of value cocreation and to identify ways to incorporate it at the strategic and operational business levels (Heinonen and Strandvik 2015).

## 30.5 Research Limitations

This study has a number of limitations. Firstly, the textual analysis does not take into account all the literature on SDL but only contributions (papers and articles) presented in the period investigated (2004–2014) and explicitly focused on the emergent topic, so contributions citing SDL but not explicitly focused on the topic have been omitted. The research approach is qualitative and descriptive, based on a text mining methodology and speculative/interpretive reflections by the authors, so it now needs to develop in a twofold direction: (1) a further qualitative study based on discussion of the ten theoretical premises of the SDL paradigm with senior management from a sample of leading companies in order to investigate the perception, possible implementation, and implications of these theoretical foundations from the

management perspective, and (2) to administer a questionnaire to academics and practitioners to measure the pervasiveness of SDL in marketing theory and practice after systemizing the key constructs of SDL emerging from the exploratory research phase. This research design should fill the current empirical research gap in the SDL literature.

## 30.6 Conclusions and Theoretical Implications

The purpose of this chapter has been to examine how SDL affects the development of a new general theory of marketing and, even more broadly, the market and the cocreation of value. This was achieved by drawing from a copious literature explicitly focused on the topic and published over a long period of time (2004–2014). Text mining analysis was performed on literature explicitly focused on the topic to explain the latent theoretical constructs of SDL and their evolutionary pattern (zooming in approach) and has shown that the theoretical paradigm has transcended its original domain (marketing theory) in the literature. Querying “Resources and Competitive Advantage”, “Service Science”, “Business Strategy Design”, “Service Innovation”, and “Network and Ecosystem” from a service and cocreation perspective has drawn the authors to an exploration of a new market creation theory and the context (ecosystem, institutions) in which resources “become” integrated and cocreate value (Chandler and Vargo 2011; Akaka et al. 2013a, b; Lusch and Vargo 2014; Koskela-Huotari and Vargo 2016; Vargo and Lusch 2016). This evolution has laid more emphasis on theories outside marketing, especially those related more to strategic innovation than marketing, thus losing sight of the original aim: to reinvent the foundational principles of marketing and the value creation process.

This shift in focus demonstrates that the paradigm has not yet been able to produce a normative theory for marketing choices or a valid alternative to traditional marketing management and the “4P” processes. In addition, the value cocreation process is still far from becoming a normative and well-defined theory applicable to management practices. The service perspective in SDL does not support and enable marketing and value cocreation practices from either the managerial or the customer perspectives. Nevertheless, SDL has created a significant impact in literature in terms of citations, articles, and forums, and nowadays it is doubtless a theoretical framework embracing a host of topics, not all of which come under marketing. An important contribution of SDL is that it has rejuvenated marketing theory. Reviewing it has contributed to improving value cocreation theory and the conceptualization of the “contextualization of value”.

The findings discussed in this chapter show that SDL has not yet achieved its original aim, namely to establish a new general theory of marketing and value cocreation. This can be attributed to the following reasons. (1) There is no convincing proposal for an alternative to the marketing management process. It is not yet

clear what the marketing levers in SDL are (who manages them and how?). (2) There has been no empirical investigation into the pervasiveness of the theoretical premises of SDL, especially from the management perspective. (3) The key proposition of SDL is that all the actors in the business ecosystem cocreate value and brand experience. However, it does not describe the value cocreation process, nor does it explicitly identify the specific role of each actor involved (customers, service providers, others) and how they relate to each other, or how the process takes place.

In addition, the inward and outward looking analysis of SDL has made it possible to identify five potential areas of conceptual alignment between SDL and Service Science: (1) the need for a greater focus on business to business (BtB) and business to institutions (BtI) perspectives, (2) while there is a valid discussion of the role of the consumer in SDL, there is too little discussion of the roles of firms and institutions and higher-level organizations at enterprise level, (3) such a discussion could be of particular relevance in the field of Service Science (BtB and BtI routes), and (4) a conscious return to the financial perspective. Value created for the customer (Sweeney and Soutar 2001; Belz and Bieger 2006) and customer equity for the firm (Rust et al. 2004)—as the total of the discounted lifetime values of all the firm's customers—have been operationalized as key metrics in GDL, and their effectiveness in evaluating marketing impact on a firm's performance is demonstrable. Recently, "public" or "extended value" configuration (Meynhardt 2009) has been introduced in marketing under corporate social responsibility (CSR), but its adoption by firms is still controversial due to the difficulties inherent in deciding who has to pay for it (Schaltegger et al. (2012). The conceptualization of value (value in use, value in context, value in life) is appreciable in SDL, but the issue of its operationalization still remains unsolved. And again, the question of who has to pay for it still remains unanswered. SDL is a new paradigm, and its definitive consolidation is also dependent on meeting the expectations of businesses and organizations regarding the evidences of any demonstrable impact of emerging SDL leverage on the company's financial performance. In the medium and long terms, SDL and Service Science have to demonstrate this financial impact (Marketing Performance Measurement route) and propose a value configuration that can be effectively operationalized for such an aim. (5) SDL has brought about a kind of a democratization and decentralization of brand that is cocreated by consumers and other institutional or business actors through their everyday experiences. This consideration has indeed been taken into account in some research fields examining the active role of consumers in contributing to brand experience in everyday life (Cook 2008; Cova and Dalli 2009; Cova and White 2010; Hatch and Schultz, 2010; Rindell and Strandvik 2010). It would therefore be opportune to examine how brand is experienced by the consumer in his or her own life and in wider society. Pen˜aloza and Venkatesh (2006) call for a greater sensibility to consumer culture in SDL, and Venkatesh et al. (2006), call for a deeper examination of the concept of the economy as a market of signs. Thus, as a new theory (Arnould and Thompson 2005; Holt 2002) is taking hold in marketing in order to understand how brand is experienced in consumers and societal culture, SDL probably has to dialogue with CCT (the

Consumer Culture Theory route). Hietanen et al. (2017) implicitly suggest it will be useful to adopt Baudrillard's (1981) distinction of four logics of value to bring SDL and CCT closer: "the first, a functional logic of use value, operates in the realm of practical operations (or utility), the second, an economic logic of exchange value, in equivalence (or market logic), the third, a logic of symbolic exchange, in ambivalence (or symbolism), and the fourth, a logic of sign value, in difference (or status)" (p. 9).

## Appendix

**Table 30.1** Interpretation of the clusters

| Cluster | Cultural space % | Label | Score |
|---|---|---|---|
| Cluster 1 | 17.69% | Business Strategy Design | 1527,376–106,956 |
| | • "Because service design is concerned with the design of services, in practice and in research, it makes sense to compare the design discipline with SDL. In this article, however, I have chosen to explore SDL and design thinking (DT) rather than SDL and service design. The main argument for this is that SDL includes both services and goods in the notion of service" (Edman 2009)<br>• "In Sect. 5, we identify the elements of a Service Dominant strategy. In this section, we use the identified elements to construct a service dominant strategy model: the service dominant strategy canvas" (Lüftenegger et al. 2012)<br>• "This view implies that strategy is concerned with developing elective resources and capabilities that "correspond to key success factors in the target market" (Day et al. 2004, p. 19). The SDL draws on a number of ideas that have been in the literature for some time (Day et al. 2004); scholars have integrated the theoretical aspects of the SDL. Drawing on the literature, the article integrates the SDL's managerial implications. Specifically, the article examines the SDL's impact on (a) firm personnel and (b) the market's competitive dynamics" (Finney et al. 2011) | | |

(continued)

**Table 30.1** (continued)

| Cluster | Cultural space % | Label | Score |
|---|---|---|---|
| Cluster 2 | 12.46% | Service Brand Experience | 2715,136–110,898 |
| | • "These experiences certainly are invaluable and more attractive to customers. Clearly, the "shared experience" satisfies customers more than just "information sharing" (receipts, ingredients) on traditional cooking websites. It enhances value co-creation by connecting people to share great experiences around cooking. With Cookpad, customers reduce the time they need to learn about preparing food and learn from others' experiences" (Doan et al. 2013)<br>• "Etgar (2008) noted that the primary motive for co-production is the desire on the part of individuals to customize experiences to suit to their needs. Within art experiences, this is very pertinent. An exchange between two focus group participants demonstrated how individuals customize art experiences to heighten the positive impact of those experiences" (White et al. 2009)<br>• "For example, Prahalad (2004) focused on cocreated brand experiences. This Author proposed, 'Experience is the brand'. Brodie et al. (2006) defined the service brand in another way: 'service brands facilitate and mediate the marketing processes used to realize the experiences that drive co-creation of value'" (Nguyen et al. 2012) | | |
| Cluster 3 | 17.85% | Value Cocreation in a Network and Ecosystem | 2410,245–100,205 |
| | • "In this service-ecosystems view, the exchange of service is mediated by networks of interconnected relationships in three ways: (1) networks enable actors to access resources through the development of exchange relationships, (2) networks provide a variety of resources for actors to adapt particular resources with their unique assortments, and (3) networks enable actors to integrate resources within a broader social context to derive unique experiences while developing new norms and meanings (i.e., shared institutions) and contributing back to the social context | | |

(continued)

**Table 30.1** (continued)

| Cluster | Cultural space % | Label | Score |
|---|---|---|---|
| | through which value is derived" (Akaka et al. 2012)<br>• "Three central terms in networks are actors, resources and activities. Network actors control resources that add value for other network members, allowing each of them to concentrate on their core competences in an integrated systems perspective (Overby and Min 2001). The network actors perform activities that combine various resources" (Fyrberg and Jüriado 2009)<br>• "Thus, the shape of the network, norms, and meanings that guide interaction among participating social and economic actors influences value co-creation. Because social contexts differ, the value determined through use and context is heterogeneous in nature, and value co-creation relies highly on the quality of an actor's surrounding network" (Akaka et al. 2012) | | |
| Cluster 4 | 21.78% | Resources and Competitive Advantage | 2940,494–102,912 |
| | • "SDL recognizes technology as bundled, operant resources. New technologies are created by developing new operant resources, finding novel ways to embed operant resources in operand resources and/or finding ways to 'liquefy' (Normann 2001) operant resources (i.e., to unembed them from operand resources so that they can be employed separately)" (Lusch et al. 2007)<br>• "Operand resources are passive resources that require action to make them valuable, whereas operant resources are active resources that are capable of creating value. Competences are embodied in operant resources and the acting of operant resources upon other resources is what constitutes service" (Poels 2010)<br>• "Therefore, if operand resources act as distribution mechanisms for operant resources, and the acquisition of these operand resources by the customer may act as a means of satisfying higher-order needs (i.e. enhancing the customers' own operant resources), then how are operant resources integrated? Allee (2008) | | |

(continued)

**Table 30.1** (continued)

| Cluster | Cultural space % | Label | Score |
|---|---|---|---|
| | proposes that intangibles (i.e. operant resources) get to market in two ways, either through conversion to monetary value or rough conversion to a negotiable form of value that can be used more informally as a type of barter" (Peters 2012a, b) | | |
| Cluster 5 | 20.62% | Theory Advancement | 3533,191–102,937 |
| | • "Marketing theory, almost by any definition, implies normative theory. A theory of the market, on the other hand, suggests a positive theory of exchange. As Hunt (2002) has stressed, normative theory normatively rests on a positive foundation: 'good normative theory is based on good positive theory'" (Vargo et al. 2010b)<br>• "However, SDL does operate as a framework for developing theory, at a paradigm level or way of thinking about how the world works (although we have consistently disclaimed paradigm status). Although SDL is not a theory per se, we do believe that building theory from an SDL foundation is the ultimate goal" (Vargo 2011)<br>• "We believe that SDL provides a framework for theorizing, confirming, and refining the theoretical foundation of service science. To have evolutionary potential, however, both SDL and service science must be cocreated. We therefore invite others to create the appropriate conceptual foundation for this new science" (Lusch et al. 2008) | | |
| Cluster 6 | 9.6% | Buyer-Seller Relationships-Performance Based Logistic | 1471,718–102,841 |
| | • "PBL uses supplier knowledge and investment to improve the reliability of the system, decrease cost, and then share in that cost avoidance. Suppliers typically have the greatest knowledge of where opportunities exist to improve products and reliability. Typically, upstream suppliers have lower costs and greater cost avoidance potential" (Randall et al. 2010) | | |

(continued)

**Table 30.1** (continued)

| Cluster | Cultural space % | Label | Score |
|---|---|---|---|
| | • "PBL converts these pools of cost avoidance into a performance-based incentive. The supplier network harvests any cost savings for a predetermined period to recoup and reward their investment and risk. Periodically, new baselines are established for supplier performance and costs. The new baselines pass cost savings on to the customer" (Randall et al. 2010)<br>• "System reliability: PBL provides greater reward potential for investment-driven improvement than sales-driven repair. Improved reliability reduces the volume of repair transactions; decreases sustainment costs, and improves system performance" (Randall et al. 2010) | | |

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# Chapter 31
# Service Economies and Complexity

**Benoît Desmarchelier**

**Abstract** The economic literature on services has for a long time been dominated by an industrialist bias which considers services as unproductive. This point of view was progressively replaced by a more positive integrative framework that takes into account possibilities of non-technological innovations. However, this framework does not constitute a theory of the growth of services and business services. We show the proximity between the integrative framework and the complex systems, and we argue that theories of the dynamics of such systems offer promising explanations for these two phenomena. In a systemic perspective, services are catalysts—i.e. actors who increasingly complexify the economic system—by taking part to various production and innovation processes at the same time.

**Keywords** Tertiarisation process · Productivity · Complex systems

## 31.1 Introduction

In economic theory, the advent of tertiary economies was either ignored or observed with fear. Services have indeed, for a long time, been characterized by a set of a priori characteristics—for instance unproductivity or immateriality—that makes empirical investigations challenging (Djellal and Gallouj 2008) and theoretical ones rather pessimistic with regards to the future of growth of service economies (Baumol 1967).[1] Yet, these economies remain the most successful ones in the world,

This chapter draws on a research carried out within the COVAL project (European Commission, Horizon 2020).

[1]See Delaunay and Gadrey (1992) for an account of this pessimistic opinion in the history of economic thought.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_31

as they are the biggest producers and exporters of agricultural, industrial and tertiary products (Hausmann et al. 2013), they attract the majority of international students in higher education (OECD 2014) and they rank on top of virtually all indicators of success (wealth, number of patents, political stability, etc.).

The debate on the contribution of services to economic growth has been characterized by three successive approaches: “industrialist”, “service-oriented”, and “integrative” (Gallouj 1994; Gallouj and Savona 2009). In the industrialist perspective, services are seen as “stagnant” activities—i.e. their productivity remains constant through time, which explains their growing importance in terms of employment (Baumol 1967). The service-oriented point of view emphasizes services-specific innovations: services do innovate, but the immaterial nature of their output makes it difficult to measure these innovations (Djellal and Gallouj 2008). The integrative view overcomes the dichotomy between services and manufacturing by merging the two previous approaches into a single framework (Gallouj and Weinstein 1997; De Vries 2006; Bryson and Daniels 2010).

The industrialist theory is deductive: it is based on a set of assumptions—for instance that services are unproductive—from which is derived a series of conclusions, notably the tertiarisation of economic activities. At the opposite, contributions in the integrative perspective are mainly empirical and conceptual, without the ambition to propose an alternative story about the tertiarisation process. Also, a common limitation in these three sets of contributions is that they are not producing a theory of the growth of employment in business services. Standard explanations for this new trend include decisions of industrial firms to externalize their service operations, and the need to access specific knowledge which is delivered by business services (Beyers and Lindahl 1996).

Our objective in this chapter is to show the proximity between the integrative framework and the theory of complex (adaptive) systems. We argue that existing theories of the evolution of such systems offer a fruitful framework for understanding the growth of services as well as the emergence of intertwining dynamics between goods and services. This conceptual proposition echoes recent contributions in economics and service science advocating for a systemic representation of economic activities (Holland and Miller 1991; Arthur 1993, 2015; Basole and Rouse 2008; Rouse and Basole 2010; Farmer and Foley 2009).

The rest of the chapter is organized as follows: a first section reviews and assesses the technologist theory about the growth of services and introduces the integrative framework as a complex system. The second section reviews some important contributions on the dynamics of complex adaptive systems and explains how they can enrich the explanatory power of the integrative approach.

## 31.2 From Dichotomy to Integration

### *31.2.1 The Unbalanced Growth Model and Its Limitations*

The model of unbalanced economic growth proposed by Baumol (1967) formalizes the standard view in economics about the growth of the service sectors in employment and national production. This model relies on a set of three hypotheses:

1. Labor productivity is constant in services, while it is growing in industry. Service activities are thus qualified as "technologically stagnant" while manufacturing ones are seen as "progressive" (see also Fourastié 1949).
2. Similar wages in service and manufacturing jobs (due to perfect labor mobility in a competitive world). It follows that wages in service sectors grow at the same rate as the labor productivity in industry.
3. High income-elasticity and low price-elasticity for service products.

The relatively high productivity growth in manufacturing sectors combined with a relatively low income-elasticity for industrial goods generate an outflow of workers from these industries, while the opposite forces—low productivity gains and high income-elasticity—create job opportunities in services in the meantime. It follows that the labor force gradually shifts from manufacturing to services. Consequences for economic growth are rather negative. The most obvious one is that, since an increasing amount of the labor force is employed in stagnant activities, the growth of national production is slowing down over time. Secondly, the share of services in the Gross Domestic Product (GDP) only increases due to a price effect, while their share in the real GDP remains constant. Indeed, a similar wage between sectors imposes that service workers are paid a wage rate greater than what they deserve in terms of productivity; costs and prices are thus rising exponentially in service sectors, making difficult any rise of service production above the rhythm of the overall economic growth. This phenomenon was famously labelled as the "cost disease" (Baumol and Bowen 1966).

Confronted with the emergence of information technologies, Baumol et al. (1985) enhance this dual conception between progressive industry and stagnant services by proposing a third class of sectors: the asymptotically stagnant services. Activities that fall into this category share characteristics with the two former sectors: they are services—thus stagnant by nature—but at the same time they make use of progressive inputs "in fixed proportions" (p. 807). This dual nature allows these services to exhibit high productivity gains in the short run, while they become progressively stagnant over time due to the aforementioned "cost disease". According to these authors, activities in communication and broadcasting are a good example of asymptotic stagnancy: thanks to their progressive inputs (e.g. electronic transmission devices) they exhibit the highest productivity gains among all sectors in 1947–1976 in the United States, with an annual growth rate in labor productivity of 5.42% (p. 809). If the theory is verified, then this rate should decrease over time. We test this prediction by computing the compound annual growth rate (CAGR) of labor productivity by sector in the United States in recent years. For the sake of

comparison with Baumol et al. (1985), we use the same (but updated) data source, i.e. the Real Value Added by Industry and the Full-Time Equivalent Employees by Industry provided by the U.S. Bureau of Economic Analysis.[2]

Results are provided in Table 31.1. From 1998 to 2015, we observe that both services and industry exhibit very heterogeneous performances. Like in Baumol et al. (1985), service sectors experience both the worst and the highest productivity growth. Interestingly, "broadcasting and telecommunication" are still one of the highest performers with a CAGR of 6.573%. This obviously contradicts the hypothesis of asymptotic stagnancy, since this rate of growth is even higher than the one reported by Baumol et al. (1985) for the period 1947–1976. Overall, all activities related with information perform very well. Also, some services traditionally labelled as "stagnant", like finance and insurance, real estate, waste management or wholesale trade are experiencing a higher growth of their labor productivity than the average of the economy.

It is well known that the growth of the labor productivity is slowing down since 2004 in most developed economies—including in the United States (Syverson 2017; Byrne et al. 2016). In order to identify the role of services in this slowdown, we divide 1998–2015 into two sub-periods in Table 31.1: 1998–2004 and 2004–2015. The slow-down is clear since the compound annual growth rate of labor productivity of the whole economy decreases from 2.294% to 0.941%. Most sectors experience a large decrease in the rate of growth of labor productivity between the two sub-periods. In line with this general tendency, several high performing services in 1998–2004, like data processing or publishing, are experiencing a significant slowdown (from 12.748% to 4.169%, and from 6.572% to 2.375%, respectively), but they remain nonetheless important drivers of economic growth, as their productivity growth rates remain significantly higher than the one of the entire economy.

All these observations are casting doubt on the empirical validity of the standard economic theory about the rise of service sectors. Indeed, stagnant services can actually be progressive, and asymptotically stagnant ones remain the most progressive over time.

Another limitation of the unbalanced growth model is that it only includes consumer services, while there also exists many business service activities in the real world. As an example, warehousing or data processing in Table 31.1 are very likely inputs of other production processes. In the context of rapid growth of employment in business services within advanced economies, Oulton (2001) enhances Baumol's framework with intermediate services. He finds that, even if business services exhibit a low productivity growth,[3] the rise of employment in these

[2]These data can be found at the following webpage: https://bea.gov/iTable/iTable.cfm?ReqID=51&step=1#reqid=51&step=2&isuri=1

Last access: Feb. 9 2017.

We use the real value added to remove potential price effects in services, and also because value added is a measure of production net from intermediate consumption.

[3]See for instance the low productivity growth of "management of companies and enterprises" in Table 31.1.

**Table 31.1** Compound annual growth rate of labor productivity by sector of activity in the United States from 1998 to 2015

| | Sectors[a] | CAGR (in %) 1998–2015 | 1998–2004 | 2004–2015 |
|---|---|---|---|---|
| Industrial sectors | Agriculture, forestry, fishing, and hunting | 2.898 | 7.286 | 0.581 |
| | Mining | 1.04 | −1.051 | 2.198 |
| | Utilities | 0.749 | 2.131 | 0.003 |
| | Construction | −1.138 | −1.373 | −1.010 |
| | Manufacturing | 3.874 | 6.908 | 2.255 |
| | Durable goods | 5.072 | 8.028 | 3.494 |
| | Nondurable goods | 2.414 | 5.334 | 0.856 |
| Service sectors | Wholesale trade | 1.862 | 3.406 | 1.029 |
| | Retail trade | 1.025 | 2.052 | 0.469 |
| | Transportation and warehousing | 0.322 | 0.809 | 0.058 |
| | Information | | | |
| | Publishing industries, except internet (includes software) | 3.837 | 6.572 | 2.375 |
| | Motion picture and sound recording industries | 2.938 | 3.121 | 2.838 |
| | Broadcasting and telecommunications | 6.573 | 7.077 | 6.299 |
| | Data processing, internet publishing, and other information services | 7.12 | 12.748 | 4.169 |
| | Finance and insurance | 2.127 | 3.666 | 1.297 |
| | Real estate and rental and leasing | 1.858 | 1.093 | 2.278 |
| | Professional, scientific, and technical services | | | |
| | Legal services | −0.787 | 0.153 | −1.296 |
| | Computer systems design and related services | 3.005 | 3.619 | 2.672 |
| | Miscellaneous professional, scientific, and technical services | 0.563 | 0.929 | 0.364 |
| | Management of companies and enterprises | 0.116 | 0.081 | 0.136 |
| | Administrative and waste management services | 2.407 | 3.622 | 1.75 |
| | Educational services | −0.457 | −0.207 | −0.593 |
| | Health care and social assistance | 0.176 | 0.669 | −0.091 |
| | Arts, entertainment, and recreation | 0.217 | −0.298 | 0.498 |
| | Accommodation and food services | −0.101 | 2.044 | −1.253 |
| | Other services, except government | −1.377 | −2.270 | −0.886 |
| | Government | 0.287 | 0.271 | 0.295 |
| Whole economy (i.e. gross domestic product) | | 1.416 | 2.294 | 0.941 |

[a]The activities labelled as "services" in this Table are those producing chiefly immaterial products. The distinction with industrial sectors is artificial, since most industrial firms offer at least some services to their clients (Bryson and Daniels 2010; Campbell-Kelly and Garcia-Swartz 2007). However, we keep it as a reference, for discussing the validity of the industrialist thesis regarding the unproductivity of services

activities paradoxically favors an acceleration of the national productivity growth rate. The intuition behind this result is as follows: any rise of productivity in a business service is directly benefiting to this activity and also indirectly to its clients' production processes. If we consider that business services have clients in many other sectors, then any small increase in their productivity indirectly fosters productivity growth of the economy as a whole. In a similar line of thought, Desmarchelier et al. (2013) build an agent-based model of economic growth in which knowledge intensive business services (KIBS thereafter) foster the accumulation of human capital and the growth of labor productivity in all other sectors of the economy.

### *31.2.2 The Integrative Approach as a Complex System*

A lesson from the previous section is that the clear distinction between industry and services found in Baumol (1967) progressively disappears, as some services include progressive (or industrial) inputs (Baumol et al. 1985), and some industries make use of (business) services in their production processes (Oulton 2001). Observing that "service functions now comprise 70–80 per cent of the 'production costs' of most manufacturing companies", Bryson and Daniels (2010, p. 83) even propose to replace the term service economy by the one of "manuservice economy" (p. 90).

In front of this progressive intertwining between industry and services, Gallouj and Weinstein (1997) propose to replace the production function, used in most economic models, by a system of interacting characteristics and actors that can be applied to both service and industrial activities (see Fig. 31.1). In this system, a product is defined as a set of service characteristics [Y], obtained through the combination of technical characteristics [X], which can be tangible or intangible, and competencies of the provider [C] and of its client [C′]. In Baumol (1967) and Oulton (2001), economic agents can only innovate by improving their technologies, hence by raising labor productivity. This hypothesis is disadvantaging service activities, because their output is difficult to measure (Djellal and Gallouj 2008). The integrative framework, on the other hand, is flexible enough to account for a wide variety of innovations (Gallouj and Weinstein 1997): radical, when all vectors {[Y], [X], [C], [C′]} are transformed; incremental, when the innovation adds some characteristics to at least one vector; improvement, when the performance of a

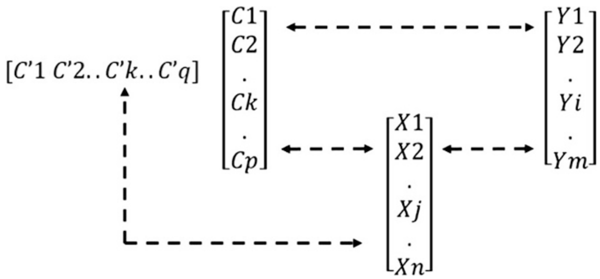


**Fig. 31.1** Product representation (adapted from Gallouj and Weinstein 1997)

characteristic is improved; recombinative, when the interactions between characteristics of the products are modified; formalization, when the innovation consists in codifying some characteristics of the product or the production process; and finally ad hoc, when an unanticipated modification occurs to at least one characteristic of the product, due to the involvement of the client in the innovation process.

Despite its numerous qualities, the framework proposed by Gallouj and Weinstein (1997) cannot replace the model of unbalanced economic growth (Baumol 1967) as a theory of tertiarisation of economic activities. Indeed, the integrative approach does not postulate differences between goods and services, nor does it formulate hypothesis about consumers' behaviors that could generate service growth.

In the rest of this chapter, we argue that system theory can enrich the integrative approach in order to provide an integrative theory of the tertiarisation process. We proceed by showing that integrative models are complex systems, and then we exemplify how theories of the dynamics of such systems can apply to the growth of services. This idea is in line with a series of recent contributions that conceptualize service activities as complex systems (Spohrer and Maglio 2010), either on the production side (Basole and Rouse 2008), organizational side (Rouse et al. 2009; Rouse 2007), or on the output side (Rouse and Basole 2010). Similarly, Gallouj and Weinstein's framework can be considered as a complex system.

There is no unique definition of complexity (Rosser 2009), but there is nonetheless a core element in all existing definitions: complexity usually refers to "systems with multiple elements adapting or reacting to the pattern these elements create" (Arthur 2009 p.12). The notion of system refers to a set of relationships—or a network—existing between these elements. The system gets complex when interactions among its elements allow for the emergence of an aggregate pattern, and when the elements react to this pattern. Complexity is not a binary state, and thus the distinction between complex and simple systems is not always easy to make.

Kauffman's (1993, 1995) NK model illustrates and quantifies the degree of complexity of a system. The model takes the form of a network of $N$ nodes—originally standing as genes—and $K$ inputs, or relations, between them.[4] If, for instance, $K = 5$ then each node is linked with five others in the system. In this specific case, any change in one node will affect five other nodes, generating a series of cascades of reactions in the other nodes with which they are linked. In this framework, a system is simple when $K = 0$, and it gets increasingly complex for higher values of $K$. The system is chaotic when $K = N$.

The production process displayed in Fig. 31.1 can be considered as a variant of the NK model in which each component of the vectors [Y], [X], [C], and [C′] is a node, with $K$ links directed towards other nodes in the system. The more a product—good or service—is complex, the higher the parameter $K$. If $K > 0$, then any innovation affecting one characteristic of the product will have a cascade of

[4]The NK model attributes a measure of performance to the different possible combinations of nodes. For the sake of simplicity and clarity, we abstract from such a measure in this chapter.

consequences on other characteristics, with a relatively unpredictable final outcome. Also, if a business service intervenes in another production process—like in Oulton's model—then we have to consider the formation of a larger network, with two imbricated systems of vectors {[Y], [X], [C], [C′]} and with relations of hierarchy between them. Hence, the economy as a whole is not anymore a collection of independent production functions—like in Baumol's model, but a large system composed of numerous interacting and imbricated sub-systems. In this context, the study of complex systems dynamics could provide a relevant framework for understanding the emergence of services, and their progressive intertwining with industry.

## 31.3 Complex Systems and the Tertiarisation Process

The integrative framework applies to both industry and services. All economic activities are thus complex systems. In this section, we start by questioning how this complexity arises, and what is specific about the role of services in complex systems. In a second part, we explain how agents' behaviors in complex economic systems can foster the growth of services, as well as their progressive mixing with industry.

### *31.3.1 The Integrative Approach as a Complex System*

Wolfram's (2002) computational experiments on cellular automata provide a good starting point for understanding how complexity can arise from simple interactions. A cellular automaton is a low dimensional system—often composed of one or two dimensions—in which each component can take a limited number of states—for instance components can be black or white. The state of a particular component changes through time depending on the states of its neighbors. Figure 31.2 displays an example of cellular automaton based on the product representation proposed by Gallouj and Weinstein (1997). In this example, the cellular automaton is a system of four components ($N = 4$), named for convenience Ck, C′k, Xj and Yi. In the simplest case, each of these components can appear in two states—for instance, 1 or 0—and thus the system offers $2^4 = 16$ combinations. If each component can take three states, then the number of potential combinations becomes $3^4 = 81$. It is important to note that not all of these combinations are possible when there exist constraints, or links, between the components of the system. In Fig. 31.2, each component has two

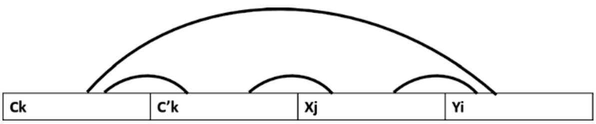


**Fig. 31.2** Gallouj and Weinstein's (1997) model as a cellular automata

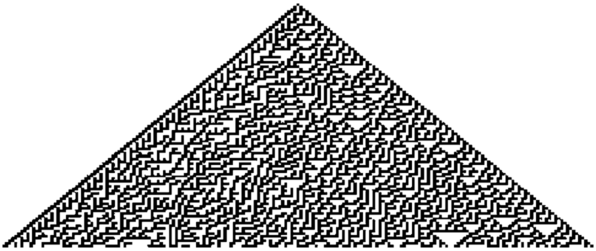

**Fig. 31.3** Cellular automaton, “rule 30”, adapted from Wolfram (2002)

links (K = 2), such that any change in Ck will affect Yi and $C'$k, and thus also Xj. Here, there are many possibilities of retroactions on Ck itself from the rest of the system, hence the final outcome of this chain of events is difficult to foresee.

Figure 31.3 provides a more concrete example of the evolution of a cellular automaton. The top row of the figure corresponds to the initial condition. Here, the central cell is black, while all others are white. Wolfram then poses the following rule of evolution (called “rule 30”): if a given cell and its right-hand neighbor are both white, then the cell takes the color of its left-hand neighbor in the following time step. If this condition is not met, then the cell takes the color which is the opposite of its left-hand neighbor. In Fig. 31.3, the evolution of this system over time is shown in the subsequent rows. With the terminology used for the NK model, we can say that $N$ is the number of cells, and $K = 2$, since each cell is linked with its two immediate neighbors.

We observe in the figure that this simple system succeeds at generating random, unpredictable, patterns.[5] This randomness is not present in the initial conditions, nor in the rule of evolution, since this later is deterministic. It is something new that emerges from the interactions between cells. As in the NK model, increasing $K$ generates more complexity, or more unpredictable and rich aggregate patterns. This example illustrates how a system like the one proposed by Gallouj and Weinstein (1997) can evolve in an unpredictable manner through innovations or interactions with the rest of the economy. In this perspective, it is striking to observe a similar movement of tertiarisation in all developed and developing economies. Indeed, this common pattern is more coherent with the existence of deterministic forces, than with randomness. Can we find an explanation for this growth of services in the laws of evolution of complex systems?

In Wolfram’s experiments, the number of links K between the components of the system is constant. However, in natural systems the number of links per component often increases over time through the action of a specific type of molecules—the catalysts—which are elements that “significantly increase the rate at which a chemical reaction happens, without being consumed” in this reaction (Hordijk 2013 p. 878). Using the terminology introduced with the NK model, these catalysts increase the ratio K/N. In random networks, a phase transition occurs when

[5]This “rule 30” can actually even been used as a random number generator (see Wolfram 2002 p. 317).

K/N = 0.5 (Erdõs and Rényi 1960). Above this threshold, random networks quickly switch from a collection of small and separated networks to a large network that includes most of the nodes N. Similarly, at this threshold, complex biological systems become "autocatalytic"—i.e. able to create novelties in a self-sustained manner (Kauffman 1993, 1995). In a sense, developed economies can be qualified as autocatalytic systems as they display a self-sustained economic growth, and they perpetually create new products, activities and technologies (Kauffman 2011).

Andersson and Andersson (2017) use this threshold property of networked systems to explain the emergence of the "first logistical revolution" in Europe that started at around the year 1000. They conceptualize Medieval Europe as a set of *N* cities, linked to each other by some trade routes. When the number of routes is relatively small, only few cities are connected to few others. However, above a certain threshold, investing in a new route allows to connect whole clusters of cities together, creating immediately a new cluster of interconnected cities—and thus a market—of unprecedented size.

Two criteria enter in the definition of a catalyst element: (1) this element is acting at increasing the connectivity between other elements of the system, and (2) it does not perish in the resulting reactions—and thus it can continue its linking activity. In this sense, firms can be thought as catalysts: they increase the connectivity between inputs of the economic system (labor, capital and natural resources) and they survive from the production process. Interestingly, with the fall of socialist economies, the twentieth century proved that such catalysts are a necessary condition for perpetual growth. In general terms, any human being can act as a catalyst, although it is not necessarily his "raison d'être", contrary to companies.

Services, as a type of economic activity, qualify as catalyst. Indeed, a service can be defined as "an operation of transformation of an element C, owned or used by a consumer (or client, or user), often in relation with this later, but without generating the production of a good likely to circulate economically independently from its support C" (Gadrey 1992 p. 17). Such activities are thus linking components of the economic system—i.e. a client and an element C—while at the same time transforming the state of at least one of these elements. There is a marked difference with industrial firms in the sense that the element being transformed does not necessarily need to be material. As a consequence, services can be considered as a more general form of catalyst, and thus as a more powerful engine of economic growth than industrial firms. Our intention here is not to oppose goods and services—most of the firms are actually providing a mixture of both (Bryson and Daniels 2010)—but to highlight that services are probably more useful for economic growth than predicted by the industrialist approach.

An illustration of the role of services as catalyst can be found in Desmarchelier et al. (2016), who look at their position in the innovation network of the aerospace cluster located in Belgium. Figure 31.4 displays this innovation network in its 2006, 2007, 2008, and 2009 configurations. White nodes represent industrial firms and the black ones are services. The links represent the existence of scientific collaboration between the actors, and the size of a node is proportional to its number of connections in the network. The more an actor is central in the network, the bigger is its

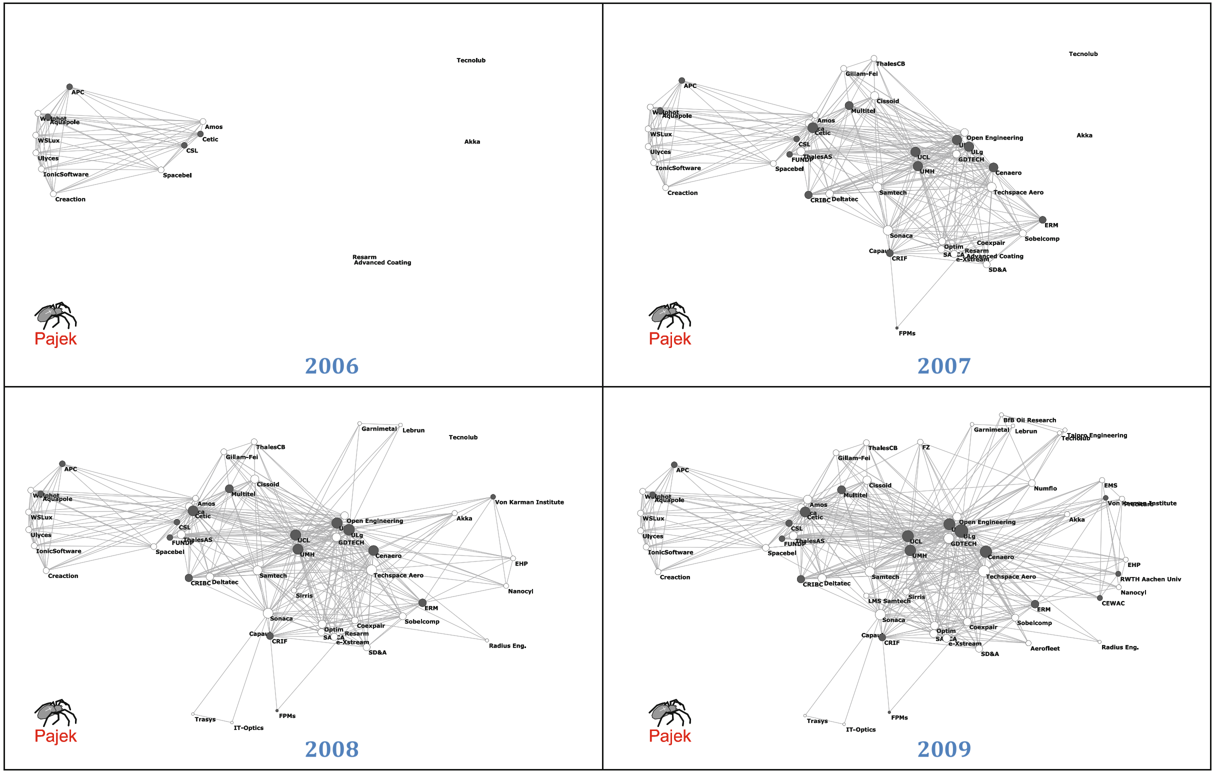


**Fig. 31.4** Innovation network of the Belgian aerospace cluster in 2006, 2007, 2008, and 2009. White nodes represent industrial ac-tors, and black ones stand for services (adapted from Desmarchelier et al. 2016)

**Table 31.2** Evolution of the number of links (K) and actors (N) in the Belgian Aerospace Cluster from 2006 to 2009 (adapted from Desmarchelier et al. 2016)

| | K | N | K/N |
|---|---|---|---|
| 2006 | 55 | 15 | 3.67 |
| 2007 | 298 | 44 | 6.77 |
| 2008 | 353 | 52 | 6.78 |
| 2009 | 441 | 61 | 7.23 |

corresponding node. Compared with the NK framework, the distribution of links among actors is not uniform, since nodes have different sizes. We observe that, in four years, the most central actors in this network are knowledge services—mainly universities, especially the Université de Liège, (noted Ulg in Fig. 31.4) and the Université Catholique de Louvain (UCL), as well as training and research centers, see for instance Cenaero. Thanks to their participation in various research projects at the same time, these services allow for the emergence of a single innovation network—i.e. they transform otherwise separated sub-networks into a large network regrouping most of the actors of the cluster. As such, any newcomer in this cluster could easily have access to partners and knowledge involved anywhere in the cluster. This small-world property of the innovation network can foster the emergence of new innovations and it makes the cluster attractive for newcomers. Table 31.2 reports the number of actors ($N$) and the number of links ($K$) in the cluster. We observe that $K$ increases faster than $N$, which implies a higher $K/N$ ratio, and thus higher innovation opportunities over time.

One could argue that the central position of knowledge services in this innovation network is sector specific or country specific. After all, national innovation systems display significant differences between each other (Lundvall 1988; Niosi et al. 1992). However, there is extensive empirical evidence supporting the instrumental role of universities in the location of firms and the development of clusters in high technology industries. For instance, Audretsch et al. (2005) find that technology-intensive firms in Germany tend to locate close to universities in order to benefit from knowledge spillovers. Grossetti (2001) explains that the early developments of research and teaching programs related with electricity at the University of Grenoble triggered the emergence of an innovation system in the city of Grenoble, transforming it into a leader in the country in computer science and electronics. Similarly, Feldman (2003) argues that the basic research carried out in American universities motivates the location decisions of firms operating in biotechnologies. There are thus reasons to believe that the central role of services in the Aeronautics cluster in Belgium is no exception.

The systemic perspective reveals that services can contribute to foster economic growth independently of their own performance in terms of productivity growth. Indeed, the most central nodes in Fig. 31.4 are universities and research and training centers, while Table 31.1 reported (in the case of the United States) that education services had even a negative productivity growth rate.

### 31.3.2 Systems Complexification as a Theory of Economic Tertiarisation

Compared with natural and artificial systems, catalysts in economic and social systems have the specificity of being purposeful agents (human beings or organizations). It is thus difficult to theorize services' role as catalyst through a conceptual framework that does not involve human action. In this perspective, the adaptive complex systems (or agent-based systems) stand as a necessary refinement for understanding services' actions in the economy. Similarly, Farmer and Foley (2009) argue that such models are needed for guiding the economic policy in a complex and uncertain world.

For Holland and Miller (1991), economies are not only complex, but also adaptive.[6] They define complex adaptive systems by three characteristics. First, they are composed by a "network of interacting agents" (p. 365). The concept of agent is flexible, as it can be adapted to systems with various degrees of aggregation. For instance, in the case of industrial clusters, interacting agents are innovative firms, public and private research centers, universities and venture capitalists, while in Andersson and Anderson's study of the logistical revolution (Andersson and Andersson 2017), agents can be European cities. Also, complex adaptive systems exhibit an aggregate behavior, whose dynamics can be thought as autonomous due to the numerous interactions between agents. Finally, such a system is adaptive when "the actions of the agent in its environment can be assigned a value (performance, utility, payoff, fitness, or the like), and the agent behaves so as to increase this value over time" (Holland and Miller 1991, p. 365). This definition does not require a specific hypothesis on agents' computing capabilities: they pursue a well-defined objective—for instance they can be profit-seeking—but without necessarily knowing how to achieve the best possible outcome with regards to this objective.

In developed capitalist economies, profit stands as the main driver of agents' actions. An example of how individual search for profit transforms agents into catalysts can be found in Hughes's study of the evolution of technological systems (Hughes 1987). In his work, the catalyst agents—called the "system builders" (p. 46)—are the engineers and the managers.[7] They are acting at improving the load factor of the system that they are managing,[8] because higher load factors imply higher returns on investment, thus higher profits. In the case of electric systems, increasing the load factor requires to make the system's output smoother through time, for instance by diversifying the populations of users and by developing the

[6]For an account of the origin of the conceptualization of economies as complex adaptive systems, the interested reader can refer to Arthur (2015).

[7]Interestingly, "management of companies and enterprises" is among the worst performers in terms of productivity growth in Table 31.1.

[8]The load factor is "the ratio of average output to the maximum output during a specified period" (Hughes 1987 p. 65).

interconnections between power plants. By doing so, the managers are acting as catalysts as they increase the ratio *K*/*N* of the electric system.

In more general terms, agents can act as catalysts in three different ways, labelled "growth in coevolutionary diversity", "structural deepening", and "capturing software" (Arthur 1993, 2015).

1. "*Growth in coevolutionary diversity*" (Arthur 2015 p. 145). At the microeconomic level, this type of action corresponds to agents' progressive specialization. This occurs when profit-seeking agents see business opportunities in new market niches. In aggregate terms, this leads to the emergence of hierarchies and input-output relations between economic sectors, cities, regions or countries (Pumain 2006). In this sense, growth in coevolutionary diversity is not specific to services. Also, collapses of coevolutionary diversity are always possible, as the appearance of new products or technologies can render existing ones obsolete.
2. "*Structural Deepening*" (Arthur 2015 p. 148). In this perspective, agents act as catalysts by modifying their own structure. In the economic world, firms have gained in structural depth by developing the multi-divisional form[9] for taking advantage of opportunities of economies of scale (Chandler 2005). Like for coevolutionary diversity, collapses can occur. For instance, big multi-divisional firms are nowadays progressively replaced by smaller networked firms (Chandler 2005; Rouse et al. 2009; Schramm and Baumol 2010).
3. "*Capturing Software"* (Arthur 2015 p. 152). "*This is the taking over and 'tasking' of simpler elements by an outside system for its own (usually informational) purpose*" (p. 152). Arthur takes the example of the electrons: engineers and scientists have progressively learned to "task" them through electronics in order to perform a variety of activities. The outside system—engineers and scientists in this case—has discovered, learned, and codified the "*grammar*" or the "*set of operational rules*" (p. 153) governing the elements which are taken over—here the electrons. Most technologies evolve through the tasking of simpler systems by more complex ones (Arthur 2009). In the biological world, colonies of bacteria are living in—and tasked by—human bodies. Another example of capturing software in social systems can be found in the birth of legal codes. In this case, the outside system is the jurist community, which is creating and enforcing laws. Progressively, jurists have regrouped and systematized laws in the form of legal codes, that can be used—or tasked—by many agents (the jurists, but also lawyers, or firms) in order to solve or avoid cases of disputes.

The variety of these examples suggests that the capturing software mechanism is pervasive in evolving systems. In human-made systems, the capture and tasking of simpler elements is conscious, and it requires many service activities: the

[9]In organization studies, the multidivisional form refers to the organization of firms' activities in segmented departments, each one being in charge of the production and commercialization of a specific product line.

identification and codification of elements to be tasked can be done through R&D and consultancy activities, while the implementation of the tasking requires monitoring services, as well as other supporting services (schools, universities, hospitals, lawyer cabinets, justice courts. . .), depending on the nature of the system that needs to be tasked. For instance, the progressive tasking of electrons required research activities, as well as schools and universities for spreading the knowledge about the principles of electricity. Hence, the capturing software mechanism can be a powerful engine driving the demand for services, independently of their characteristics in terms of labor productivity or prices.

Besides, the previous example on the role of services in the shaping of the Belgian innovation network in aeronautics shows that the relationship between services and complexity is not unidirectional. Not only service activities emerge through the complexification of the economic system, but they also contribute to make the system increasingly more complex. For instance, Gallouj (2002) indicates that KIBS are specialized in processing and transferring knowledge to their clients. Using the terminology of the capturing software, KIBS companies represent the outside system, which transforms tacit and/or codified knowledge from the client and other sources into an operational system, executable (or tasked) by the client firm. KIBS are thus economic agents which are specialized in proposing capturing software services to their clients. As a consequence, services are both a product and a producer of complexification of the economic system through capturing software.

## 31.4 Conclusion

This chapter has started by questioning the industrialist assumption of the unproductivity of services and the traditional distinction between goods and services. Figures of the U.S. productivity growth rate at the sector level reveal that some services are structurally among the best performers in terms of productivity growth, in particular those making use of significant technological inputs. Goods and services are thus more mingled than postulated by the theory.

The integrative approach of service production and innovation is more convincing on a descriptive basis, but it is lacking in terms explanatory power. Stressing the intellectual proximity between this approach and complex systems, we argue that existing theories about the dynamics of these systems can enrich the integrative approach with a theory of the growth of service sectors. Under this framework, the emergence of services and their progressive intertwining with industry can be explained as both a consequence and a cause of the complexification of economic systems. Profit-seeking economic agents act as catalysts—i.e. they increase the intensity of interactions between economic agents and components (technologies, natural resources, etc.)—through various strategies (specialization, structural deepening and capturing software) that generate the appearance of new activities—including services—which further complexify the economic system.

Developing a complex integrative framework and providing empirical evidence of the role of services as system complexifiers represents a promising research agenda in the economics of services. It could provide an alternative to productivity measures for assessing services' contributions to economic growth.

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# Chapter 32
# From Whence to Where in Service Science: A Perspective on the Field

**Janet R. McColl-Kennedy**

**Abstract** This paper traces the origins and evolution of Service Science, identifying influential conferences and workshops, key journals, communities of interest and individuals that have shaped the development of this burgeoning field. Discussion then turns to key concepts before looking ahead to the future and sketching out important future areas for research and practice. Subsequently, the author then reflects on the evolution of her own research in Service Science outlining research topics and contributions, acknowledging the work of co-authors. Finally, a road map is offered to the next generation of Service Science researchers keen to carve out a contribution and make a difference.

**Keywords** Service Science definition · Evolution of Service Science · Service Science conferences · Service Science Service concepts · Science research agenda

## 32.1 Early Beginnings

Defined as "the study of service systems, aiming to create a basis for systematic service innovation, service science combines organization and human understanding with business and technological understanding to categorize and explain the many types of service systems that exist as well as how service systems interact and evolve to cocreate value" (Maglio and Spohrer 2008, 18). In essence, service science combines organization and individual understanding with business and technology understanding with the view to explain and design service systems.

Service Science emerged a decade ago as a new field of scientific endeavor coinciding with Maglio and Spohrer (2008), the first Service Science *Handbook* (Maglio et al. 2010) and Ostrom et al.'s (2010) Research Priorities for the Science of

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_32

Service. These publications have been instrumental in providing guidance for researchers interested in working in this exciting field.

Service Science has emerged as a significant field supported by a number of communities of interest from the combined work of many researchers and practitioners across the globe brought together by several influential meetings, workshops and service journals. The next section discusses these influential conferences and workshops, followed by key journals, communities of interest and lead contributors.

## 32.2 Influential Conferences and Workshops

Several conferences and workshops have played important roles in bringing together both academics and practitioners from different disciplines and from around the world in pursuit of greater understanding of Service Science. Four scientific meetings in particular have been especially influential in shaping Service Science and includes: (1) Frontiers in Service; (2) Forum on Markets and Marketing (FMM); (3) Naples Forum on Service; and (4) CTF Karlstad, Sweden. Each is now discussed in turn.

### *32.2.1 Frontiers in Service*

The *Frontiers in Service* conference has provided an important meeting place for new ideas, concepts and methods to be aired and interactions among thought leaders to take place resulting in highly impactful publications, spawning new research projects, as well as tools and techniques to be implemented in service organizations. The 2006 Frontiers in Service conference (co-chaired by Professor Roland Rust and Professor Janet McColl-Kennedy) held in Brisbane, Australia, is one case in point. Here Dr. Jim Spohrer from IBM's Almaden Research Center, San Jose, USA spoke about the criticality of having "T" shaped employees who were not only well-versed in technical details from their professional training demonstrating deep knowledge and skills, but were also able to communicate effectively across the organization, displaying important "people" skills to effectively connect and co-create value with their colleagues. In the following year Dr. Jim Spohrer (IBM) and Dr. Paul Maglio (IBM) co-chaired the 2007 Frontiers in Service in San Francisco with Professor Roland Rust. This was the first time the conference had been hosted by an industry partner. At this meeting IBM played a major role with several sessions chaired by IBM employees. Thanks to Wendy Murphy's (IBM) organizational skills, and co-founder of this Springer series in which the handbooks are published, attendees were treated to a most memorable evening cruise in San Francisco Bay as fireworks lit up the city skyline for fleet week.

### 32.2.2 Forum on Markets and Marketing (FMM)

The first Forum on Markets and Marketing (FMM) was held in Sydney in 2008, chaired by Professor Roger Layton (University of New South Wales) and Professor Stephen Vargo (University of Hawaii) and Professor Bob Lusch (University of Arizona). (Roger Layton is now Emeritus Professor at the University of New South Wales.) This "by invitation only" meeting introduced researchers to Service Dominant (S-D) logic which proposed a useful theoretical lens to study service, facilitating healthy debate. The primary purpose of the *Forum* was to advance the development of S-D logic by focusing on foundational issues related to markets and marketing and exploring the cross-disciplinary foundations of S-D logic. To accomplish this aim a small number of scholars actively engaged in dialogue and discussion over several days. The second FMM was held at the University of Cambridge UK in 2010 and chaired by Professor Andy Neely (University of Cambridge) and Professor Bob Lusch and Professor Stephen Vargo. The third FMM was held in Auckland New Zealand in 2012, co-chaired by Professor Rod Brodie (University of Auckland) and Professors Vargo and Lusch. FMM 2014 was hosted by the CTF Service Research Center at Karlstad University, Sweden and co-chaired by Professors Bo Edvardsson and Anders Gustafsson (Karlstad University). Again healthy debate ensued and several thought provoking articles resulted. See for example McColl-Kennedy et al. (2015b). Following the Karlstad meeting the FMM2016 was held in Venice, Italy co-chaired by Professor Irene Ng (University of Warwick) and Professors Vargo and Lusch. FMM2018 co-chaired by Professor Hope Jensen Schau (University of Arizona), Professor Stephen Vargo and Assistant Professor Melissa Archpru Akaka (University of Denver) is scheduled to be held in Tucson, Arizona USA in December 2018 building on the foundations of the previous Forums.

### 32.2.3 Naples Forum on Service

The Naples Forum on Service was established in 2009 with the first conference hosted by Professor Francesco Polese (University of Salerno, Italy), Professor Evert Gummesson (University of Stockholm, Sweden) and Professor Cristina Mele (University of Naples "Federico II", Italy) in Capri, Italy. Since its founding, the biannual Naples Forum on Service has become an important event for the community of service academics and practitioners, focused on: service-dominant (S-D) logic, service science, and network/systems theory. A key goal of the Naples Forum is to encourage an integrative perspective in research, bringing together academics and practitioners from a wide range of disciplinary backgrounds, while also facilitating networking among participants.

### *32.2.4 CTF Karlstad, Sweden*

CTF was established in 1986 by Professor Bo Edvardsson and has more than 60 researchers and doctoral students from disciplines such as business administration, psychology, information systems, environmental and energy systems, and working life science. Currently CTF is headed up by Director, Professor Per Kristensson, and Vice director, Professor Per Skålén and focuses on contributing to scientific knowledge on value-creation through service. CTF has close links with industry including for example Ikea, Volvo and Ericsson. Professor Lars Witell heads up the research profile Service Innovation for Sustainable Business (SISB) which was launched in September 2011. Working with their industry partners SISB focuses on identifying the DNA of service innovation.

## 32.3 Key Journals

It is encouraging to see a growing number of service journals many of which are interested in publishing quality interdisciplinary research. Although not the only journals, three in particular encourage multidisciplinary Service Science research. They are the *Journal of Service Research*, *Journal of Service Management* and *Service Science*.

The *Journal of Service Research (JSR)* founded by Professor Roland Rust in 1998 has played a critical role in publishing interdisciplinary service research, specifically highlighting that it aims to publish cutting edge research not only from the Marketing Discipline but from Computer Science, Operations and related disciplines including Engineering. Indeed, the Editorial Review Board has leading researchers from these disciplines. More and more papers are being published on big data, machine learning and the integration of Artificial Intelligence (AI), not only in service development and design but also in service delivery. Following Roland Rust's Founding Editorialship, Professor Parsu Parasuraman (University of Miami) became Editor, and subsequently Professor Kay Lemon (Boston College) and Professor Mary Jo Bitner (Arizona State University) served as Editors. Currently, Professor Michael Brady (Florida State University) is the Editor of *Journal of Service Research*.

Professor Jay Kandampully (Ohio State University) is the current Editor of the *Journal of Service Management* having taken over the role of Editor of the *Journal of Service Management* in 2010 from Professor Bo Edvardsson, Karlstad University, Sweden. The *Journal of Service Management* is a truly transdisciplinary journal publishing quality work from marketing, operations, human resources and management across a range of topics including technology, innovation, ecosystems, the changing role of the customer, and service experience.

*Service Science* founded in 2012 focuses on the study of complex services and service systems, and is interested in publishing high quality articles from a range of

disciplines, including operations, industrial engineering, marketing, computer science, psychology, information systems, design, and more. Effective understanding of service and service systems typically requires combining multiple methods to consider how interactions of people, technology, organizations, and information create value under various conditions. Professor Paul Maglio (University of California Merced) is the current Editor.

## 32.4 Communities of Interest

Although not limited to the below mentioned communities of interest, six communities of interest are worthy of particular note. They are: Cambridge Service Alliance, UK; International Institute for Product and Service Innovation (IIPSI), The University of Warwick UK; CTF Karlstad, Sweden; The International Society of Service Innovation Professionals (ISSIP); Center for Service Innovation (CSI), Norwegian School of Economics (NHH), Norway; Cornell Institute for Healthy Futures (CIHF), USA; and The University of Queensland's Service Innovation Alliance (SIA), Australia.

### *32.4.1 Cambridge Service Alliance*

Many groups of researchers around the world operate and focus on Service Science. Among the notable examples is Cambridge Service Alliance at the University of Cambridge, UK headed by Professor Andy Neely (Director) and Deputy Director Mohamed Zaki. Cambridge Service Alliance is a global alliance between leading businesses and universities. Founded by Cambridge University, in alliance with several companies including BAE Systems, IBM, Caterpillar, CEMEX, the Alliance was formed in 2010 and is designed to bring together some of the world's best firms and researchers devoted to delivering today the insights, education and approaches needed for the Complex Service Solutions of tomorrow. The focus of the work to date has centered on the shift from manufacturing to services, ecosystems, customer experience, smart cities with particular attention devoted to big data, technology and artificial intelligence (AI). The Alliance grew out of an important early publication sometimes referred to as the Cambridge-IBM SSME report on "Succeeding Through Service Innovation" (IfM and IBM 2008).

### *32.4.2 International Institute for Product and Service Innovation (IIPSI)*

Professor Irene Ng is Head of Service Systems and Marketing and Director of WMG's International Institute for Product and Service Innovation (IIPSI) at The University of Warwick, UK. IIPSI aims to provide businesses with access to the latest cutting-edge product and service design technology, leading to the creation and testing of market leading products, services and new business models. A major focus of IIPSI is the Internet of Things (IoT).

### *32.4.3 CTF Karlstad*

For over 30 years the CTF at Karlstad University, Sweden has undertaken research in service(s). Professor Bo Edvardsson and Professor Anders Gustafsson have hosted several workshops focusing on service science topics and bringing together thought leaders who have led research teams resulting in articles published in the *Journal of Services Marketing* and *Journal of Service Management* that not only facilitated discussions around important research topics but set future research agendas. See for example, Gustafsson et al. (2015) on undertaking research that matters and Andreassen et al. (2016).

### *32.4.4 The International Society of Service Innovation Professionals (ISSIP)*

ISSIP is a professional association co-founded by IBM, Cisco, HP and several universities with a mission to promote service innovation in an interconnected world. The association focuses on supporting a multidisciplinary perspective and provides an online speaker series (including AI and service via Cognitive Systems Institute Group (CSIG)), and has a short book series with Business Expert Press. ISSIP also sponsors two systems-oriented service science tracks at conferences, including HICSS.org and AHFE-HSSE.org. In addition, ISSIP endeavors to maintain "ISSIP Ambassadors" to a wide range of other communities, including INFORMS Service Science and AMA ServSIG.

### 32.4.5 Center for Service Innovation (CSI) Norwegian School of Economics (NHH)

Chaired by Professor Tor Andreassen, CSI, Norwegian School of Economics aims to: enhance the service innovation capabilities of its business and research partners; improve the commercial success of Norwegian service providers' service innovation activities; and measure Norway's service innovation capability. CSI has an advisory board comprising ten members with representatives from the host institution, user partners, KIBS-partners and research partners as well as an International Scientific Advisory Board (ISAB). ISAB members comprise Dr. James Spohrer, IBM, USA; Dr. Irene Ng University of Warwick, UK; Dr. Roland Rust Robert H. Smith School of Business at the University of Maryland, USA; Dr. Janet McColl-Kennedy, UQ Business School, The University of Queensland, Australia; Dr. Timothy Keiningham St. John's University, USA and Dr. Stephen L. Vargo University of Hawaii, USA. The ISAB annually reviews and provides advice on the vision, focus, research programs, participation of senior scientists and activities of PhD students.

### 32.4.6 Cornell Institute for Healthy Futures (CIHF)

Founded in 2015 Cornell Institute for Healthy Futures Cornell University, USA is headed up by Professor Rohit Verma. Cornell Institute for Healthy Futures aims to become a world leader in integrating the fields of hospitality, design, policy, and management to advance service excellence in healthcare, wellness, senior living, and related industries. Twenty-seven faculty members from other universities representing 12 countries are affiliated with CIHF as Academic Scholars. CIHF Academic Scholars come from a range of disciplines and collaborate in research projects, educational activities, or industry events linking hospitality, health, and design.

### 32.4.7 Service Innovation Alliance (SIA) at the University of Queensland

The Service Innovation Alliance (SIA) is a multidisciplinary team of faculty members from marketing, tourism, management and strategy at the University of Queensland, Brisbane, Australia engaged in service research headed up by Professor Janet McColl-Kennedy and Professor Brent Ritchie. A key aim is to undertake innovative, timely, high quality research and training that informs the future of service organizations. A number of faculty members engaged in the 2017 Thought Leaders Conference, held at the University of Queensland, Brisbane in November 2017 and chaired by Professor Janet McColl-Kennedy (UQ), Professor Byron Keating

(Australian National University), Associate Professor David Solnet (UQ) and Professor Jay Kandampully (Ohio State). This workshop based "by invitation only" conference brought together prominent thought leaders in Service Science to set research priorities and shape future research. Over 60 scholars attended from around the world, comprising eight teams. Eight pairs of co-leads were selected to lead the development of the papers. The eight co-leads were: Professor Ruth Bolton (Arizona State) and Professor Janet McColl-Kennedy (UQ); Professor Simon Bell (University of Melbourne) and Professor Rod Brodie (University of Auckland); Professor Tor Andreassen (NHH Norwegian School of Economics) and Professor Line Lervik-Olsen (BI Norwegian Business School); Professor Paul Patterson (University of New South Wales, Sydney) and Professor Jochen Wirtz (National University of Singapore); Professor Bo Edvardsson (Karlstad University, Sweden) and Professor Pennie Frow (University of Sydney); Professor Byron Keating (Australian National University) and Paul Maglio (University of California, Merced); Professor Mahesh Subramony (Northern Illinois University) and Associate Professor David Solnet (UQ). Each team worked together on a distinct strand of research to develop a thought piece paper which is published in a Special Issue (Volume 29, Number 5) of the *Journal of Service Management* in 2018.

## 32.5 Key Concepts

Service Science has focused attention on service systems, ecosystems and how service systems interact and evolve to co-create value. Several researchers[1] have contributed to the growing field of Service Science and influenced my own work. Researchers have examined value co-creation, unpacking what value co-creation is and operationalizing value co-creation (McColl-Kennedy et al. 2012). Key components of value co-creation—activities, interactions and roles—have been studied,

[1]Examples of contributors to Service Science, who have been my collaborators and/or key influencers: Tor Andreassen (Norwegian School of Economics), Simon Bell (University of Melbourne), Mary Jo Bitner (Arizona State University), Ruth Bolton (Arizona State University), Michael Brady (Florida State University), Rod Brodie (University of Auckland), Tracey Danaher (Monash University, Melbourne), Bo Edvardsson (Karlstad University), Pennie Frow (University of Sydney), Anders Gustafsson (Karlstad University, Sweden and BI Norwegian Business School), Jay Kandampully (Ohio State), Timothy Keiningham (St. John's University, New York), Kay Lemon (Boston College), Line Lervik-Olsen (BI Norwegian Business School), Bob Lusch (deceased, previously University of Arizona), Paul Maglio (University of California, Merced), Cristina Mele (University of Naples "Federico II", Italy), Andy Neely (University of Cambridge), Irene Ng (University of Warwick), Amy Ostrom (Arizona State University), Adrian Payne (University of New South Wales), Parsu Parasuraman (University of Miami), Paul Patterson (University of New South Wales), Francesco Polese (University of Salerno, Italy), Roland Rust (University of Maryland), Jim Spohrer (IBM, Almaden Research Center), Jill Sweeney (University of Western Australia), Stephen Vargo (University of Hawaii), Rohit Verma (Cornell University), Jochen Wirtz (National University of Singapore), Lars Witell (Karlstad University, Linkoping University, Sweden), Mohamed Zaki (University of Cambridge).

including interactions between firms and customers and between customers and other customers. Interest has been given to the nature of the changing role of customers/consumers. Considerable attention has been directed at S-D logic—including the key concepts and axioms (Vargo et al. 2008; Vargo and Lusch 2016). Many service science researchers view S-D logic as providing a useful framework for their work, providing a common language and worldview for service scientists (Maglio and Spohrer 2008). More recently attention has been given to service experience and the factors that impact on service experiences (see Bolton et al. 2014; Bolton et al. 2018). Technology has been an important theme of Service Science research with attention being devoted to using technology to enhance service design, delivery and service experiences. Digital technologies, such as mobile, artificial intelligence (AI), virtual reality (VR), wearable technologies, neuroscience, digital twins and machine-to-machine interactions through the Internet of Things (IoT) are changing the way we interact, changing customer behavior, and how organizations and networks are organized and at times blurring the lines between humans and machines (Lemon 2016).

## 32.6 Going Forward

It is expected that technology will be an important area of research focus. Especially given the growth in AI, it is expected that this will not only continue but increase going forward. Perhaps the most profound technological impact will come about from augmented reality (AR). Attention has focused on service experience and this is an area that is likely to receive attention in the future. Future research could pay particular attention to how augmented reality might provide better service experiences (Bolton et al. 2018). Research into drones is likely to increase as they offer great potential in delivering physical goods and some services, especially in rural and remote areas and where the terrain is difficult to access. While technology is increasingly influencing many aspects of service, it is critical to investigate the intersection of the digital, social and physical realms as we are likely to see service being delivered in different hybrid forms such as by humans with robots, and though devices and humans and robots. Another potentially fruitful area is in emotions and well-being and while work has commenced (McColl-Kennedy et al. 2017a) there is considerable scope for further development. Going forward it is expected that service science research will focus more on the human side, such as emotions/affect and culture and on transformative service, including for example, improving healthcare. In this regard data security and privacy are likely to be important areas for future research and practice.

## 32.7 Evolution of My Research

My own research, focused on Service Science, has been greatly influenced by working with collaborators from different disciplines, primarily Engineering, Computer Science, Management and Medicine. Working with co-authors from different disciplines can enrich the research by providing different lens to investigate the phenomenon of interest and proffer different measurement and analysis tools. In the following section I outline some of my key papers.

Health Care Value Co-creation Practice Styles (McColl-Kennedy et al. 2012), published in *Journal of Service Research*, was one of the first papers to show *how value co-creation can be operationalized*. In this paper we argue that key elements of value co-creation are customer: (1) activities, (2) interactions, and (3) roles. That is, the way a customer, in our case, a health care customer (patient), sees their role influences what activities and interactions they engage in, which in turn impacts on their well-being. Operationalized in health service, this highly cited paper is the first of a number of related papers that investigate the changing role of patients in the design and delivery of their health care. This paper provided the foundation for Sweeney et al. (2015) that demonstrates that *some activities involve more effort* on the part of the customer than others and that there is a *hierarchy of activities* with some activities more effortful than others. We found that the least effortful activities are complying with basic requirements of the medical staff at the clinic and putting effort into relationships with friends and family. While those activities that require the largest amounts of effort include proactive involvement in decision making and connecting with others (not family and friends) who had a similar illness.

Regarding *value co-creation activities*, our McColl-Kennedy et al. (2012) paper also laid the foundation for our "Cocreative Customer Practices: Effects of Health Care Customer Value Cocreation Practices on Well-being" paper published in the *Journal of Business Research* (McColl-Kennedy, Hogan, Witell, and Snyder 2017). This paper, drawing on three studies using data from six separate samples of 1151 health care customers, shows that while positive interactions with medical staff (doctors) lead to increased well-being through engaging in coproducing treatment options, interactions with friends and family and their associated co-created activities have an even greater positive effect on well-being. Importantly, several other *customer*-directed activities have positive indirect effects. Interestingly, activities requiring change can have a negative effect on well-being, except in psychological illnesses, where positive direct effects of change on well-being were evident.

We explore *service ecosystems* in a study with Pennie Frow and Adrian Payne, published in *Industrial Marketing Management* (Frow et al. 2016). In this paper we develop a typology of co-creation practices that shape a dynamic health care service ecosystem, identifying practices that have positive effects, negative effects, and those that can have either positive or negative effects on the service ecosystem. We also provide indicative measures of co-creation practices. In short, we argue that co-creation practices play a central role in shaping the service ecosystem, influencing which resources are available, when they are employed, and how they are integrated.

Our typology consists of eight co-creation practices which we illustrate in the context of a health care ecosystem.

In McColl-Kennedy et al. (2017c) we investigate the *changing role of the customer* in health care settings. While traditionally customers have been viewed as having a relatively passive role, largely a recipient of what an organization does for them (Payne et al., 2008), the passive role of healthcare customers (patients) is increasingly being viewed as limiting in the further development of healthcare (Hardyman et al. 2015). Therefore, instead of viewing customers as passive, merely responding to market offerings, customers can be active and in healthcare. This means that the customer (patient) can have a much more active role in their care by contributing a range of personal resources such as information and knowledge, and by engaging in a range of activities by themselves and with others to improve their health and well-being (McColl-Kennedy et al. 2012; Ostrom et al. 2015). In this paper we review the changing healthcare customer role, synthesizing healthcare and service research literatures and identifying ten key practice approaches. Changing the healthcare customer role can improve satisfaction, quality of life, and health outcomes. However, a change in the customer's role does not automatically lead to positive effects. We argue that there is a need to further investigate both the positive and negative effects of the changed customer role within an ecosystem comprising collaboration between multiple actors in an ecosystem such that the roles, activities, and responsibilities of healthcare customers, professionals and friends and family change.

Regarding *service experience*, we developed a paper on service experience from reviewing practices across a range of service organizations arguing that service experience can provide a useful differentiating strategy for firms (Bolton et al. 2014). Following on from this paper we set an agenda for Service experience in our collaboration and subsequent paper from the 2014 Karlstad FMM workshop (see McColl-Kennedy et al. 2015a, 2015b) and then empirically investigated service experiences in aged care (McColl-Kennedy et al. 2015a). We explored the importance of integrating the digital, physical and social realms of the service experience in Bolton et al. (2018) and sought to theorize to the year 2050, offering a research agenda. We are currently revising a manuscript on managing the customer experience using big data.

Following our earlier work on customer anger and customer rage (cf. McColl-Kennedy et al. 2009; Patterson et al. 2016), we explore the dynamic nature of *emotions* using healthcare as a context (see McColl-Kennedy et al. 2017a). A further paper, currently in development, models patient emotions over time and provides guidelines for health care providers on how to better manage patient emotions. Another study under review investigates emotions in a B2B context, again providing practical guidelines for managers to better manage customer emotions in the service experience.

## 32.8 Advice to the Next Generation of Service Science Researchers

First, get involved and actively build your network. Attend specialized conferences and workshops where you can interact with key people in the field. There are many ways to get involved. You could, for example, volunteer to help at conferences and workshops. You need to be proactive. Don't wait for someone to come looking for you. Ask to be part of a research project offering to undertake literature reviews, checking references, data collection activities, undertaking data analyses, as well as offering suggestions on where you believe gaps might be in the topic given your "up to the minute" knowledge of the literature. You have skills that others, even very senior academics, may not have which you can bring to the project.

Second, be courageous. Be willing to explore new topic areas, learn new tools of data collection and data analysis. Take some risks. New technologies, including text mining, data analytics offer great opportunities. Be open to suggestions from others. You don't need to accept all of them, you couldn't anyway. Ask questions of more senior researchers. Look for new ways of doing things that can make a difference—a difference to service experiences, enhancing well-being. Research in healthcare is particularly rewarding and with so many technological advances, such as robotics, AI and VR, this would appear to be a well-worthwhile area to work in.

Third, look for opportunities to work with industry. The Service Science community is comprised of both academics and practitioners. Universities are encouraging, if not requiring, academics to make connections with industry through collaborative projects, and or industry funded grants and secondments. Collaborations between academics and practitioners can be challenging as these different communities may have very different frames of reference, different time lines, and different Key Performance Indicators (KPIs). However, they can be most challenging and rewarding collaborations of your career.

Fourth, you need to learn to love writing. Be prepared to revise, revise and revise your work. You need to get used to having rejected manuscripts. The important learning here is to learn from the reviewers' comments. In my experience, reviewers do not set out to make your life difficult. Reviewers typically have spent hours reading your work and reflecting on it. They do this voluntarily. They are not paid for this work. My advice is that you should carefully consider what they are saying. I always try to think about how I could improve my paper and avoid that problem in the next draft. Always try to write so that you cannot be misunderstood. Write, write, write! It is interesting to look back at the first draft and see how much the manuscript has improved after the fourth draft or 14th draft! When responding to reviewers always be professional. Don't take it personally. They are critiquing what you have written, not you.

Fifth, be strategic. Think about where you want to contribute and make a difference. What do you want to be known for? There are so many wonderful opportunities to work in especially with the new technologies, the blurring of boundaries between humans and machines and big data. Service Science is a

growing field offering exciting opportunities to work on significant real-world problems where you can make a difference. I wish you well in your journey of discovery and application.

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# Chapter 33
# Embedding Humans into Service Systems Analysis: The Evolution of Mathematical Thinking About Services

**Alexandra Medina-Borja**

**Abstract** Current technology-driven innovations in service systems tend to replace human workers with machines, rather than engineering a partnership between the two. Engineering this cooperation is not an easy task, and requires cyber-physical systems that seamlessly adapt and respond to unexpected human interactions. This chapter provides an overview of how mathematical modeling of service systems with human-machine cooperation is evolving. In addition to the modeling challenges, a historical view of modeling humans in service systems is presented, including current promising work and tools, such as deep learning, and Markov process approaches to model human behavior and interaction. The chapter also explores using other mathematical paradigms and creating a new mathematical language to model humans.

**Keywords** Human-machine partnership · Mathematical modeling · Cyber-physical-human service systems · Service system design · Convergence

## 33.1 Introduction

Current technology-driven innovations in service systems tend to take the human server out of the loop. This substitution of human labor will potentially affect the United States and other developed economies, as the service sector in these countries is responsible for the majority of employment. To improve this outlook, rather than replacing human workers with machines, one could think of an engineered partnership between human and machine agents. For example, improvements in healthcare and education sectors will use people to do what people do best (e.g. creativity,

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_33

synthesis, improvisation, social skills) and machines to do what machines do best (e.g. fast processing of massive amounts of data, precision, application of force) in effortless cooperation with one another. Engineering this cooperation is not an easy task as it implies that cyber-physical systems can adapt and respond to unexpected human interaction in a seamless way. Thus, to improve operations and activities in services, there is a need for more sophisticated modeling of the human agent that relies on new hardware, computational power, and analytics to understand complex human interactions in tandem with or mediated by cyber-physical systems.

One obstacle to engineering effective human-machine partnerships is the lack of a mathematical framework that allows the multiple disciplines that study service systems to translate human models into a single language for engineers. Existing disciplines have worked on different aspects of this problem, from the identification of key human factors that need to be understood to the advancement of computational frameworks to process human-generated data, forecast the best next step, or simulate and mimic human processes. The study of emerging cyber-physical-social systems can inform service scientists designing service systems with optimized human-machine collaboration. This consideration necessarily would require behavioral and cognitive sciences to converge with other disciplines. As defined by the National Academies, *convergence* is a research approach that cuts across fields to tackle societal problems that can only be solved by melding knowledge at the intersection of two or more disciplines.

To overcome the inherent challenges of convergence, we need a shared mathematical language connecting behavioral and cognitive scientists with engineers and vice versa. This middle ground could conceivably be the right meeting space to foster the mathematical language that could incorporate those human characteristics that need to be modeled. This mathematical language or framework could be based on advances in the calculus of finite differences, Markov chains, or a completely different paradigm. We are just beginning this exploration.

In this chapter, I am concerned with the inclusion of humans or human features in service system modeling as the first step toward achieving a true partnership of humans and machines in service systems. A human-centered service system is a socio-technical system where technology and people interact to co-create value or to benefit one another (Spohrer et al. 2007). Qiu (2009) summarized the difficulties of modeling humans as “people participating in service production and consumption have physiological and psychological issues, cognitive capability, and sociological constraints, etc.” p. 42.

Technology traditionally mediated the information necessary to provide a service, but in the last 20 years, technology has become more than a mediator, often serving as a de-facto service provider, generating independent and intelligent actions that co-create value. Consider service robots, cognitive assistants, or autonomous vehicles. Facilitating the real interaction of humans and machines has brought up new engineering challenges that include from sensing and actuation to mathematical modeling of control systems that considers human inputs, and the subsequent optimization models that consider human variability as integral part of the system. Physical interactions require modeling beyond understanding language, thus

understanding gestures, emotions, physical approach, etc. In addition, modeling human behaviors, intentions, cognition, and actions is required in the design of effective human-machine interaction.

The idea of modeling humans is not new. Human computer interaction (HCI) experts study three aspects of human modeling: cognitive, physical and affective factors that have an impact on how users relate to technology at the interface level. HCI researchers try to understand how memory and cognition work to develop designs that make the best use of human capabilities. In HCI, researchers have considered human-machine interaction as an input-output system, where perceptions are inputs and the responses to stimuli are outputs. However, the type of mathematical model I refer to in this chapter goes well beyond interface design in the HCI sense. Modeling, being physical or predictive, ideally uses sensed data of cognitive, behavioral, physiological and social cues of people in the system. In the emerging field of interaction design, having knowledge of what are the likely human reactions to the machines is essential. Cognitive engineering, a branch of human factors engineering, has also experimented with computational models of human cognition or cognitive architectures in a simulated environment for human-machine interaction design (see Byrne (2002) for a review of this field). Thus, knowledge about humans exist that could be integrated into our analysis of service systems. My aim is to begin to build a catalog of appropriate models.

In this chapter, I (1) provide an overview of the modeling challenges; (2) provide a history of modeling humans in service systems, including approaches used by marketing, decision sciences and operations management communities not always targeting human cooperation with machines, but at least including the human in the analyses; (3) cover models used in service systems that are starting to include human considerations; and (4) touch on current promising works and tools such as deep learning and Markov process approaches to model human behavior and interaction. I conclude with potential work that the community needs to advance, perhaps using other mathematical paradigms or by creating a new mathematical language to model humans.

## 33.2 Service System Modeling, Analysis and Design: A Trajectory of the Inclusion of Humans

Human-centered design is an art. By contrast, engineering design involves quantitative knowledge of how systems behave and of the physical properties of materials and objects accompanied by a systematic design framework, which allows engineers to put together systems that perform according to specifications. The linkage between the two, the art of design and the engineering of systems that involve machines and humans could be made through operations research (OR). According to the Institute of Operations Research and the Management Sciences (INFORMS), the field of OR is the application of scientific and mathematical methods to the study

and analysis of problems involving complex systems. Yet, in practice, this potential for the application of mathematical modeling to human-centered systems has been slow to take off.

In the summer of 1965, O'Meara (1965) published an article entitled "The Challenge of Operations Research". O'Meara was a practitioner in large government and industry organizations, not an academic. Still, his article foretold the research problems of importance for the times. He called for the social sciences to be included in modelling operations with the purpose of solving real and substantial problems. He compared the circumstances of his time with the problems scientists were unable to solve in the thousands of years between Archimedes and Galileo. Galileo thought differently and with the help of improved measurements, could see the solution to the structure of the solar system, thus developing the heliocentric theory. Many other very smart physical scientists and mathematicians were unable to get out of their own realm of knowledge, and therefore, were unable to solve this and other unsolved problems at the time. According to O'Meara, scientists saturated with prior misconceptions are unable to solve more complex problems that require interdisciplinary thinking. From my perspective, O'Meara was advocating for the "convergence" of social and behavioral sciences with the physical sciences and engineering, and importantly, he prescribed a formula for it: first one needs to ask the right question. One needs to forget what one knows and then take a fresh approach at the problem. In the case of operations, the first thing is to forget about modeling and remember that we are trying to relate observed phenomena so that we can predict behavior and attempt to control it, improving it according to certain system performance metrics.

Since 1965 there have been few attempts of modeling social or human elements in operations research. In 1986, John Little published a note in *Management Science* that reported on an NSF-funded workshop upon the inauguration of the Decision and Management Sciences program (today housed in NSF's Social, Economic and Behavioral Sciences Directorate), which made clear the need to include theories about human behavior, cognition, and decision making in operations research formulations (Little 1986) where human judgement is involved. Few others have introduced human factors in formulations since, until very recently in the service systems space.

I will not provide an exhaustive recollection of all papers on service systems or service operations that have advanced human models, but I aim to provide a general overview of what has been done in this regard. I have included papers that were either unique in their approach or considered seminal by the service science community. For a nice review of the beginnings of service operations, refer to Johnston (1999) or to Rust and Chung (2006), who also provided a comprehensive overview of models of service and its evolution in the marketing literature. These authors acknowledge that to the early 1980s, there was little serious modeling, followed by a dramatic increase in models in the service sector in the last two or three decades, attributable to the increase of low cost data generated by the internet and ubiquitous mobile technologies, joined by growth of focused research in service marketing and service operations. Finally, operations research models in the areas of routing,

supply chain, yield management, and scheduling are generally the product of modeling service application areas.

Following Johnston (1999), I see three historical waves in the modeling of services: The first starting with the recognition that services are different than physical goods and therefore, are produced differently; the second emerging with the development of conceptual frameworks, and the empirical testing of those frameworks; and the third incorporating computational models to understand complexity, or the emergence of service systems thinking and a concern for interaction design (see Table 33.1).

### *33.2.1 The First Wave: Models Use Probabilistic Distributions as Approximations of Human Behavior and Choice*

The first wave of service models ended in the late 1970s or early 1980s. During this time, the focus was on the use of mathematics to understand the behavior of marketing campaigns and predict revenue in services. In fact, some of the first references to modeling service systems started in the marketing literature. In 1963 Kotler published an article in the *Journal of Marketing* entitled "The Use of Mathematical Models in Marketing" (Kotler 1963). In this article, Kotler proposed that the new "marketing man" should not be afraid of using mathematical tools to do "his" job. The article describes mathematical and statistical methods, such as matrix algebra, calculus, simulation, linear programming, utility indexes, and probability as concepts or tools to perform the necessary analyses. The application areas suggested were wide, but two were waiting lines and brand-switching models. In both cases, humans are the ones waiting in line or switching preferences, and both cases involve service interactions. Still, the individual socio-economic or attitudinal characteristics of the people in the system were largely ignored, and the models used approximations or probabilities for expected group behavior. Since then, a lot has changed in the marketing field. Marketing is perhaps the most prolific area of knowledge in services and service systems research in general, and statistical models and linear programming models are common.

### *33.2.2 The Second Wave: Models of Service Performance and Supply Chains Include Perceptions and Expectations Using Aggregate User-Reported Data (Late 1980s to Early 2000s)*

The second wave is characterized by research in service operations, including modeling of supply chains, and the measurement of service quality and service

**Table 33.1** Phases of modeling services with people

| Phase | Typical models in the literature | Characteristics of the inclusion of humans |
|---|---|---|
| The first wave: marketing uses probabilistic distributions as approximations of human behavior and choice (1960s to 1980s) | Waiting lines<br>Brand-switching models | • Individual attitudinal or socio-economic characteristics are ignored<br>• Models use approximations or probabilities for expected group behavior<br>• Applications in banks, supermarkets, and other services |
| The second wave: models of service performance and supply chains include perceptions and expectations using aggregate user-reported data (late 1980s to 2000s) | Modeling of supply chains<br>Measurement of service quality (e.g., SERVQUAL, SERVPERF)<br>Measurement and benchmarking of service system performance (Balanced scorecard; Data Envelopment Analysis of service systems)<br>Psychology is introduced as a factor in queuing lines | • Human attitudes and perceptions are collected through surveys<br>• Hard system performance measures are also used (e.g., number of complaints)<br>• Results are used in aggregate<br>• Notions of treating services as systems start to percolate<br>• Applications in all types of service organizations, from Banks to educational institutions |
| The third wave: the operational model becomes service-focused and service system design incorporates interaction design and advanced analytical methods to tame complexity (2000s to 2010) | Revenue management and dynamic pricing models for services sold on-line incorporate game theoretical models<br>Methods to analyze systems complexity such as agent-based modeling (ABM) and system dynamics (SD) mathematically explore the emergent dynamics of a complex system<br>More complex scheduling algorithms and modeling of services using dynamic programming are possible | • Computational power enables more complex modeling that may involve human agent rules and the result of interactions<br>• Service encounters can be modeled<br>• Human agent incentives and outcomes are modeled based in game theory (behavioral economics gain popularity)<br>• Nash equilibrium is widely used in many applications<br>• Decision processes at the individual level can be modeled. In ABM, each agent individually assesses its situation and makes decisions based on a set of rules that are computationally processed |
| Present times: an evolving modeling paradigm to accommodate personalization and | Models for personalized services or user-adaptive systems | • User's preferences and behaviors are collected through ubiquitous mobile |

(continued)

**Table 33.1** (continued)

| Phase | Typical models in the literature | Characteristics of the inclusion of humans |
|---|---|---|
| the cooperative and adaptive smart service system (2005 to present) | (from e-commerce to e-learning) | devices<br>• User-adaptive systems adapt their contents, configuration and interface according to the user model<br>• User model preserves preferences, interests, behavior, knowledge, goals and other user facts<br>• Algorithms are designed to imitate human mental activity, such as learning and pattern recognition<br>• Voice recognition and translation applications that enable a more natural interaction with "engineered" service providers<br>• Voice-search and image-search applications<br>• More accurate prediction helps to improve the dynamics of complex models |
| | Artificial Neural Networks and Deep Learning algorithms for prediction, classification, data association, data conceptualization and data filtering<br>The integration of NN into agent based modelling enable agents to make decisions based on data from human based simulations | |
| | Markovian models that depict processes that do not depend on the history of past states, and are independent of time<br>Modeling variations are Markov Chains, Markov Decision Process, Hidden Markov Model and Partially Observable Markov decision process | • Make possible adaptation and co-adaptation<br>• Used in combination with other modeling and simulation techniques to model human factors<br>• Capturing human sequence learning abilities; develop interactive and socially appropriate behaviors in intelligent machines such as service robots; train intelligent systems to co-adapt<br>• Natural dialog interaction between machines and humans is made possible (e.g. Siri)<br>• Modeling of customer behavior in service systems and prediction of customer satisfaction and evaluations of service quality |
| | Machine learning and deep learning enable machines to acquire their own knowledge by extracting patterns from | • E-commerce applications such as offering customers new items and narrowing downs their search based on |

(continued)

**Table 33.1** (continued)

| Phase | Typical models in the literature | Characteristics of the inclusion of humans |
|---|---|---|
| | raw data. Human intervention is necessary for background knowledge, the operational phase is expected to be without human interaction<br>Three types:<br>– supervised learning, such as regression models, neural networks, support vector machines, random forests and boosting algorithms<br>– Unsupervised learning attempts to acquire patterns in the input, and then classify them into appropriate groups based on important features<br>– Reinforcement learning leads to an optimal solution by an iterative trial and error process of reward signal evaluation of pairs of input and outputs | their interests<br>• Language understanding, object recognition, speech perception, and prioritization of results<br>• Systems must be able to evolve and optimize a performance criterion to adapt to the environmental changes to which they are exposed over time<br>• Understanding human behavior based on analysis of Big Data<br>• The input from the model is represented by visible layers that correspond to the features we can observe. Hidden layers determine what features are significant and important for explaining the relationship in the data given by visible layers and consequently, the network can determine and map this relationship |
| | Neural networks become more than two layers deep: Deep learning, hierarchical learning or deep structured learning<br>There is no need for human specification of knowledge, and therefore the computer solves more intuitive problems by learning through experience | • Simpler concepts on the top of each other are built from more complicated ones, forming a deep graph with many layers<br>• Deep learning can learn more complex level representations and features based on a huge amount of unlabeled data<br>• Social Physics is launched to make sense of ubiquitous big human and social network data |

system performance. In these models, humans are included by way of attitudes and perceptions collected through surveys that are used to arrive at conclusions about the quality of a service, or to make predictions about different operational aspects of a service system. The second wave includes service quality and service performance frameworks, including aspects of service benchmarking, and logistics and supply

chain models applied to services, including the psychology of waiting lines in queueing theory.

The evolution of models of service described by Rust and Chung (2006) started with conceptual models of service quality in the early 1980s (e.g., Parasuraman et al. 1985, and Grönroos 1984), such as SERVQUAL and SERVPERF, among others. These models included people in the sense that they were based on large data collection efforts asking customers what they look for in great service, i.e., their perceptions and expectations. Such models were conceptual models, but in cases such as SERVQUAL, they are also a survey instrument that can be adapted to different services, ultimately asking human customers for their expectations along with their after-service perceptions. They presume that statistical categorical data analysis methods will be used to make sense of the data. Perceptions of the human customer about the empathy of the service provider, the reliability of the service, the appearance of the physical facilities, etc., were part of such conceptual models.

In the 1990s, scholars expanded concerns with service quality to other service system performance dimensions. The balanced scorecard and similar conceptual models were used frequently in services and humans were included largely based on survey responses. These surveys mostly addressed two dimensions of the scorecard: the customer perspective and the learning perspective, but proxy metrics of human interactions with the service represented by hard metrics of performance were also used, such as percentage of complaints (see, for example, Kaplan and Norton 1996).

#### 33.2.2.1 Benchmarking Performance

One of the main criticisms of balanced scorecard approaches for operational improvement is precisely its multi-dimensionality. In the late 1970s, Charnes et al. (1978) proposed a linear programming method that would take care of evaluating the technical efficiency of production units, whether services or manufacturing, or any other system that could be represented by a set of multiple inputs and a set of multiple outputs, regardless of their dimensional units. This technique was named Data Envelopment Analysis (DEA). A Google search shows that the Charnes et al.'s seminal paper has more than 26,000 citations to date, and has been applied in all sorts of systems, including thousands of service systems (see, for Cook et al. 2014).

DEA is based on a series of production axioms derived from microeconomic theory, which apply mostly to manufacturing production and may or may not hold for service systems. Yet few academics have voiced concerns about the treatment of the production axioms in a service context. The major limitation of DEA is that it is a benchmarking technique, and so the analyst must collect data on at least ten or more similar productive units to calculate the relative efficiency of each unit with respect to the others.

The advantages of DEA are plenty, including but not limited to the fact that quantitative recommendations or "targets" (in the DEA jargon) are derived from the calculations performed for each non-performing unit in the sample. Targets are calculated by measuring the radial or non-radial distance from a non-performing

unit to the mathematical best-practice "frontier" formed by the spatial set of highly-performing units in the sample. Because it is a nonparametric technique, DEA can be applied to compare units that use very different resources and produce different types of products or services. Also, because it is nonparametric, DEA does not require an assumption of a functional form of how the inputs are related to the outputs. The only limiting requirement is that its use assumes that the principle of interchangeability among inputs and inputs/or outputs and outputs, holds (i.e., substitution effect).

DEA has been applied to hospitals, banks, hotels, schools, humanitarian organizations, universities, human services, etc., and adaptations and modifications to the original Charnes et al. model have been advanced to deal with several data and operational issues (e.g., Banker et al. 1984; Ruggiero 1998).

DEA formulations can include aggregate characteristics of humans in the system, such as socio-economic factors affecting operations using any of the Ruggiero's formulations, for example, but this is not a generalized practice for the analysis of service systems with DEA. In general, what happens in the service system is deemed a black box and the only variables of importance are the inputs and the outputs. However, in manufacturing processes, there is a line of research that uses DEA to find potential optimal combinations of resources (raw materials for example) as inputs. When linked to the output produced, these DEA models provide alternative configurations like the results obtained in design of experiments or multi-criteria decision making. Likewise, this approach could be used for service design parameters by considering some human factors that are deemed important to define the service encounter. Yet, people are largely ignored in mathematical formulations of service systems' performance to date.

#### 33.2.2.2 Logistics and Supply Chain Models

Researchers started to model incentives and outcomes of supply chain behavior in the late 1960s but it was not until the 1980s that such modeling became common. Forrester (1961) and later Sterman (1989) discussed the bullwhip effect and modeled it with the use of differential equations or system dynamics modeling. Later, many others modeled this effect and its relationship with many other factors (e.g. Lee et al. 1997). In the late 1980s and throughout the 1990s, supply chains and routing and scheduling models for freight service providers started to populate the literature. Meredith and Roth (1998) performed an analysis of the explosion of papers in modeling supply chains from 1995 to 1997. Retailing and the need for managing ever more distant global echelons of the chain, paired with a frenzy run for electronic management through ERP systems, were the reasons for the shift to supply chain research. In the late 1990s, supply chain researchers also started to recognize service components. Most of these supply chain or product-service models used game theoretical approaches (e.g., see Cohen and Whang 1997). Wilson and Woodside (1994) found that demographic and psychological traits of the decision maker (s) influenced organizational purchasing decisions (Stock 1997). Stock proposed borrowing from psychology's stage theory to determine degrees of variability in

inputs and outputs common to firms, including individuals dealing with logistics. Still, whereas game theory or decision models imply that human judgement is involved, with few exceptions, no direct appearance of human characteristics as variables are found in those models.

#### 33.2.2.3 Psychology of Waiting Lines

Perhaps one of the most visionary areas of mathematical modeling developed during this second wave was that of the psychology of waiting or queuing that recognized the human as an essential element of the system. This is one of the most interesting cases of human behavioral and cognitive considerations in the service operations research literature. Psychological factors in queuing have had wide impact to the modeling of services. Probably one of the first mentions of the psychological element involved in customer satisfaction and customer abandonment when the expected time in the line is discouraging was that of Sobel (1973), which saw this problem from the micro-economics perspective and offered analytical solutions for several competing service facilities. Over a decade later, Larson (1987) offered the perspective of social justice in the psychology of queues. Larson discovered that the waiting perception, and subsequently, the satisfaction of the person being served, was greatly impacted if the FIFO (first in-first out) rule is violated, therefore resulting in a strong perception of social injustice. Larson adds social injustice to the description of the utility of participating in a waiting line when he says (p. 895):"For the great majority of queuing system customers the actual and or perceived utility of participating in the system is (1) a nonlinear function of queuing delay, and (2) multiattributed."

After Larson's noteworthy paper, several others introduced behavioral and cognitive factors that affected the traditional mathematical formulation in queuing models. This traditional formulation prescribed that in any system where the service capacity is exceeded by demand for service, waiting is an inevitable outcome. Work in the marketing literature regarding queues suggested that there is a huge perception component that has the "service environment" as a big factor in this affective response to waiting (see for example Baker and Cameron 1996 and Unzicker 1999), suggesting that perception of time is subjective. In the operations literature, research in service operations for which waiting is part of the service design started to focus on the relationship between waiting policies and satisfaction when demand exceeds capacity, such as in the entertainment industry like in movie theaters and amusement parks (Dawes and Rowley 1996), emergency rooms and bank branches (Jones and Dent 1994) and supermarkets (Bennett 1998). Davis and Heineke (1994) proposed that customers' degree of satisfaction with waiting determined service quality, and in turn service quality was related to the customer's expectations regarding that performance, and the customer's perception of the service encounter. They proposed five main queue perception factors/categories of waits that included unfair versus fair waits, uncomfortable versus comfortable waits, unexplained versus explained waits, unknown versus known waits, and initial versus subsequent waits.

All can be considered binary variables or within a scale from super-unfair to somewhat-unfair, for example.

However, defining their distribution is a more difficult problem as it depends largely on a combination of circumstances, including the personality or characteristics of the human server and customer.

By the end of the 1990s, research started to consider product-service systems, where mixed models were required to understand the relationship between customer satisfaction, waiting and production of some sort of goods, such as in fast food establishments (Church and Newman 2000). Thus, additional factors that affected the customer's perception of wait were investigated (see Durrande-Moreau 1999 for a compilation). But then again something else started to concern service research, and that is the inclusion of psychological factors in service experience design (see in particular Dansky and Miles 1997, as well as Ariely and Zauberman 2000 for an example of an empirical investigation of patient satisfaction in healthcare services related to different structures of waiting time and filling time).

#### 33.2.2.4 Yield Management and Services

Around the same time, the service-profit-chain was proposed by Heskett et al. (1994) and Heskett et al. (1997) offering a framework that links satisfied and motivated employees to satisfied customers who in turn tend to purchase more, increasing customer loyalty that in turn increases revenue and eventually the profit of the organization. This framework has become the basis for several empirical studies about service systems. Managing the factors involved in the service-profit chain is a type of yield management strategy in service systems. Most papers in this area are studies collecting data from customers, testing hypothesis and arriving at conclusions based on statistical analyses. These are necessary and important but not the types of mathematical models that this chapter suggests will advance the field.

### *33.2.3 The Third Wave: The Operational Model Becomes Service-Focused and Service System Design Incorporates Interaction Design and Advanced Analytical Methods to Tame Complexity (2000s to 2010)*

At the onset of the twenty-first century, computational power, the advent of the Internet and the appearance of mobile devices acting as ubiquitous data collectors fostered a change in the research approaches used to study ever more prevalent service systems in the economy. The promise of e-commerce set up by the 1990s started to become a reality in the 2000s and service exchanges started to be done more and more through the WWW. The terms "service" supply chain and

"product-service" supply chain started to be used even more frequently (Wang et al. 2015), and with them the application of the same methods used for product-only supply chains to these new types of systems (thus ignoring the inherent human component).

#### 33.2.3.1 Incentives and Choice in Game Theoretical Model Approaches

The field of revenue management for services increased in importance in the new century (e.g., Bernstein and Federgruen 2004). Revenue management algorithms included dynamic pricing formulations typically applied to the hospitality and travel industries for transactions conducted online. These models speculate on the incentives and consequent behavior of customers. Incentives are manipulated using probabilities of demand fluctuation (e.g., see Jain and Kannan 2002). Choices are conceptualized as utility functions and represent mathematical formulations that consider human behavior and decision making in service settings. In that way, analytical game theoretical methods or game theoretical approaches considering incentives that influence the choices that agents make (agents could be humans interacting in the system) have been used in other applications. See examples for service supply chains (Akkermans and Vos 2003; Cachon and Netessine 2006), for e-commerce, including evolutionary game theoretical approaches, such as pricing differentiated services or price competition (Johnson and Whang 2002 and Armony and Haviv 2003). Game theoretical approaches have been also applied to transportation (e.g., Bell 2000), health services for the triage of patients in emergency rooms (e.g., Wilk et al. 2005), and organ transplant waiting lists using human choice as a utility function or probability distribution (e.g., Su and Zenios 2004). It has also been applied in humanitarian services such as those that involve an assessment of risk by the humans in the system, where each person updates his or her selection based on a Nash Equilibrium principle, such as in the case of forced evacuation and choice of emergency exits (e.g., Ehtamo et al. 2008).

#### 33.2.3.2 Modeling and Simulating Complex Service Systems and Human Interactions

By 2010, advanced analytical tools and greater computational power enabled methods to analyze system complexity such as agent-based modeling and system dynamics (e.g., Lee 2007). More complex scheduling problems over time and space (e.g., Mahmoudi and Zhou 2016) and genetic algorithms and dynamic programming applications appeared in the service operations literature together with more traditional methods potentiated by this additional computational power, such as large DEA formulations with thousands of units in the sample (e.g., Medina-Borja and Triantis 2014).

Others started to use different analytical frameworks to depict service system interactions with humans and service processes, advancing mathematical

representations of the service system abstraction (Qiu 2009). For example, one of the computational thinking methods advanced by Qiu was a mathematical model conceptually showing the relationships and dependencies among the entities in each process. This mathematical model was later translated or formally defined as a workflow net with defined conditions and tasks. Soon, this framework could be extended to address the problem of task allocation in the human-machine partnership in services.

#### 33.2.3.3 Modeling Users and Interactions in Services

Agent-based modeling (ABM) became a popular modeling and simulation approach when researchers wanted to model autonomous entities or agents, each presenting differentiated behaviors; the interactions between agents in turn gives birth to resulting system-wide emerging behaviors. According to Epstein and Axtell (1996), each agent individually assesses its situation and makes decisions based on a set of rules that are computationally processed to mathematically explore the emergent dynamics of the system.

Bonabeau (2002) stated that agent-based modeling (ABM) is an appropriate technique to model and simulate human systems. This author describes four main areas of application for ABM: flow simulation, organizational simulation, market simulation, and diffusion simulation. All four are compatible with service systems. In fact, ABM could be used to model advanced interactions between agents (service recipient, service provider, machine, business, etc.).

ABM's computational requirements may be problematic, but the advantages are many. The specific interactions between the components of a system are made clearer with this modeling process. Proper use of ABM can lead to a more profound understanding of the emergent properties of a service system. A few example applications of ABM include models to analyze the effectiveness of urban evacuation (Chen and Zhan 2008), service provider and service recipient interactions, to test organizational design alternatives in service networks (Herrera-Restrepo and Medina-Borja 2018) and more importantly for this chapter, agent-based modeling has been used to model users of a service system as they interact with technology.

System dynamics modeling (SD), a second well-known approach to understand complexity, in turn could be used to model service systems that consider characteristics of a human population in aggregate. This computational approach involves the development of simulation models that portray processes of growth (accumulation) and feedback loops that are analyzed by solving simultaneous differential equations using software developed for that purpose. Just as with ABM, these computational models can be used to perform experiments that will test the outcomes of policies in different types of system configurations over time. In general, health systems or public policy problems are modeled with this approach. In fact, computational power and software innovations have enabled very complex systems to be modeled and simulated. For example, Homer and Hirsch (2006) used this simulation approach to

include not only disease outcomes, but also health and risk behaviors of the population treated, environmental factors, and health-related delivery systems.

### *33.2.4 Present Times, an Evolving Modeling Paradigm to Accommodate the Cooperative and Adaptive Smart Service System*

Given that service encounters are crucial for satisfaction, it is not a surprise that advances in computational models have enabled modeling of encounters as service recipient-service provider interactions, or human user-machine interactions when the machine either intermediates the service or is the de-facto service provider. The challenge now is to design and optimize a service system that uses technology that recognizes human intentions, feelings, perceptions, and social context so that the system can adapt to cooperate with people.

The spread of systems that gather personal information about the user has led to the reproduction of user's preferences, knowledge, activities, etc., over many applications that can recognize a person, customizing the service offering accordingly. User-adaptive systems from e-commerce to e-learning, from tourism to digital libraries, have emerged. According to Carmagnola et al. (2011), a user-adaptive system adapts its contents, configuration and interface according to the user features contained in the user model. The user model usually preserves human user properties such as preferences, interests, behavior, knowledge, goals and other facts that are deemed relevant for a user-adaptive application. The user model is a key component of an adaptive system. The quality of personalized service depends on the characteristics of the user model.

The rest of this section describes computational methods that started to be regularly used back in the early 2000s, but that have been boosted by additional computational power during this decade, are briefly described. These paved the basis for other methods being used to generate the necessary interaction modeling. Neural networks, Markov processes and Deep Learning are introduced in the context of their use in service applications, where some sort of human characteristics are predicted or analyzed.

#### 33.2.4.1 Neural Networks

The term neural network (NN) was first used in biological sciences to describe animal's nervous systems and its neurons networks (Arbib 2013). An artificial neural network is a modeling tool that is an adaptation of the processes by which we believe the brain to operate, designed to imitate human mental activity, such as learning and pattern recognition (Behara et al. 2002). The network is composed of artificial neurons or nodes that represent neurons or nerve cells in the human brain. NNs

also became known as neural nets, artificial neural systems, parallel distributed processing systems, and connectionist systems (Mehrotra et al. 1996).

Neural network research is not new, but it was only in the late 1990s that enough computational power made it possible to really take advantage of their potential benefits (Mehrotra et al. 1996) and now its future continues to depend on further hardware development. Back in 1943, McCulloch and Pitts demonstrated the application of neural networks in Artificial Intelligence (McCulloch and Pitts 1990). The most known NN algorithms are: Back-Propagation, Perceptron, Hopfield Network and Radial Basis Function Network (RBFN) (Brownlee 2016).

Negnevitsky (2005) suggested that an artificial neural network (ANN) can be expressed by processors or "neurons that are connected with each other. The structure of the network is composed of layers that feed forward. The node of the structure represents processing units that are connected by weighted links, also known as arcs. These weights denote the importance or strength or each neuron input and through their adjustment, the network can evolve and learn (Freeman and Skapura 1991; Negnevitsky 2005).

Anderson and McNeill (1992) divided potential applications for neural networks" into five categories: prediction, classification, data association, data conceptualization and data filtering. Most of the applications in the literature provide some sort of benefit or value, and one could argue that most of them are in fact representations of services. Current applications of neural networks include areas such as accounting and finance, health and medicine, engineering and manufacturing, marketing and others (Paliwal and Kumar 2009). Engineering applications of NN are plenty, including image processing and control theory. Neural networks have been adapted in finance services for bond ratings, debt risk assessment, and credit approval, and are revered as powerful tools for stock-market predictions (Trippi and Turban 1992). In the field of medical diagnostics have started implementing neural networks to compare different models of data to get a clearer picture of the situation and diagnose a patient more accurately (Lisboa and Taktak 2006).

Many applications of neural networks to service systems have been also reported. When modeling complex systems, it is crucial to understand the dynamic of agent responses and so, the integration of NN into agent based modelling can play an important role. A framework in which the agents make decisions based on the network training process that used data from human based simulations provides more accurate prediction of complex systems and helps to improve the dynamics of models (Laite et al. 2016).

#### 33.2.4.2 Markov Process

A Markov process can be defined as a type of stochastic process in which past history is not relevant to update the system state if the present state is known (Mae 2016). According to Sheskin (2010), though a stochastic process can be defined as a sequence of random variables that generate a random process, the state of the system can be understood as the values that random variables can assume. The most four

common Markov models according to different characteristics of the system are Markov chain, Hidden Markov model, Markov decision process and partially observable Markov decision process (see (Sonnenberg and Robert Beck 1993). Here, I provide a brief description of the model and its service application in this context.

#### 33.2.4.3 Markov Chain

Markov chain is a type of chance process developed in 1907 by A.A. Markov in which the outcome of the next experiment is affected only by the outcome of the current experiment (Grinstead and Laurie Snell 1997). In fact, this independency of the process from past history, also known as Markov property, has been widely used to study and analyze different physical, economic and social systems (Sheskin 2010). Currently, Markov chains have been widely applied in operations research, artificial intelligence and computer science (Gouberman and Siegle 2012). Markov chain models are used in services for operations planning when adaptability to unexpected situations is needed, as in the case of emergency services (Alanis et al. 2013) and to introduce patient length of stay and staff utilizations in care delivery services (Wang et al. 2014). More importantly, Markov Chains have started to be used to model human factors needed to model and design cooperation in service systems, such as to capture human sequence learning abilities (McComb et al. 2017), to develop interactive and socially appropriate behaviors in intelligent machines such as service robots (Liu et al. 2016), and to learn to co-adapt mimicking the case of human-human interaction as the naturalness of the dialogue increases in spoken dialogue systems, where the dialogue manager and user simulation evolve over time (Chandramohan et al. 2014).

#### 33.2.4.4 Markov Decision Process

Markov Decision Processes (MDPs) can be understood as a discrete-time model consisting of a finite set of states in which a set of actions will be taken by an agent in each of them. Every action chosen in a specific state has a specific probability and is based on a policy mechanism (Brázdil et al. 2017; Gouberman and Siegle 2012). According to Gouberman and Siegle (2012), Markovian processes have some peculiar characteristics: they do not depend on the history of past states, they are stationary, which means that the same action is taken in recurrent states, and is independent of time (Brázdil et al. 2017). It is important to emphasize that these characteristics are valid only if the planning horizon is infinite (Sheskin 2010). The agent who chooses the actions to be taken can get a sequence of rewards that can be both positive or punishments (Poole and Mackworth 2010). In a finite planning horizon, an optimal policy can be found and the goal of the model is to maximize the rewards until it reaches an end boundary (Sheskin 2010). In services, MDP has been used to simulate clinical decision-making processes in healthcare (Bennett and

Hauser 2013); to improve semantic interpretation frameworks underpinning natural language interaction (Bellegarda 2014), and to manage a variety of adaptive web services such as streaming and resource allocation in cloud services (e.g., Bokani et al. 2015), to name a few.

#### 33.2.4.5 Hidden Markov Model

According to Sheskin (2010), there are some cases in which the states from the model are not clear to the observer, and therefore a new approach of Markov Chains had to be developed to solve those situations. This approach is known as Hidden Markov model (HMM). In fact, in HMMs there are two different kind of states: observable and hidden states (Ching and Ng 2006). Emam and Aaghaie (2011) illustrate several applications of Hidden Markov models, including evaluation and analysis of service quality perception by human customers. The authors demonstrated that HMM can be applied for modeling new customer's behavior. Likewise, Zhang et al. (2016) reported that is essential for a service provider to understand behavior patterns of its customers to offer better services and get new clients. Therefore, the authors proposed a new framework based on a multi-state model and a hidden Markov model to model users' mobile online behavior that can be used as a guide for service providers in designing, operating, and marketing. Bila et al. (2013) demonstrated that HMM can be used for human-computer interaction.

#### 33.2.4.6 Partially Observable Markov Decision Process

In simple terms. Poole and Mackworth (2010) define a partially observable Markov decision process (POMDP) as an affiliation of Hidden Markov Models and Markov decision process. On this model, there are some noisy observations or only some parts of the state are observable.

Many more Markov process applications on service systems can be found than the ones mentioned here. Still, several do not reference modeling human characteristics in the service system. For example, Li and Jiang (2013) applied Markov chain models from an operational management point of view to optimize problems involving basic product-service systems. Andersen et al. (2017) used a homogeneous continuous-time Markov chain to model patient flow and patient reallocation in a healthcare service system facility. Others have been able to model customer special behavior problems, including brand loyalty and brand switching in distributed service networks where admission control (AC) technology plays an important role for performance improvement of the system (Lu et al. 2014).

#### 33.2.4.7 Machine Learning and Deep Learning

Some machines are capable to acquire their own knowledge by extracting patterns from raw data, a phenomenon known as machine learning (ML) (Bengio et al. 2016). Without question, many aspects of modern society have been deeply impacted by these machine learning systems that seem to accomplish simple results easily understood by humans (Michie et al. 1994). The outputs from these systems being used in service systems include, but are not limited to offering customers new items and narrowing down their search based on their interests; language understanding, object recognition, speech perception, and identifying and favoring significant results of online searches (Yann et al. 2015). It is important to emphasize that even though human intervention is necessary for background knowledge, the ML systems operational phase is expected to occur without human interaction. Consequently, to adapt to the environmental changes to which they are exposed over time, these systems can learn through time by themselves, and evolve and optimize a performance criterion (see Michie et al. 1994; Alpaydin 2004). These systems do that by experience or example data.

Russell and Norving (2004), classified machine learning tasks into three different groups based on the feedback available to the learning system and the nature of the learning signal: supervised learning, unsupervised learning and reinforcement learning.

*Supervised learning*: the main characteristic of a supervised learning network is the training data provided by a supervisor to the model (Pacheco 2015). This network utilizes a set of descriptive features based on past experiences to make predictions for new occurrences (Kelleher et al. 2015). In this context, during a training process, an external agent provides ideal outputs to model with the goal of learning and developing other outputs (Heaton 2015). Nevertheless, Surton and Barto (1988) had already stated that this alone is not appropriate for learning from interaction. Pacheco (2015), emphasizes that this model can result in two different types of prediction outputs: numeric, for a regression problem, or a class, for problems of classification. The most known models of supervised learning are: regression models, neural networks, support vector machines, Random Forests and Boosting algorithms.

*Unsupervised learning*: this model is also known as unsupervised or self-organized learning (Negnevitsky 2005). The target is to acquire patterns in the input, and then classify them real time into appropriate groups based on important features. The learning process of this model is fast. (Alpaydin 2004 and Negnevitsky 2005).

*Reinforcement learning*: this type of modeling leads to an optimal solution by an iterative trial and error process of reward signal evaluation of pairs of input and outputs (Sutton and Barto 1988). Aldrich and Auret (2013) describe the focus of this model as finding a learning space balance between current knowledge and exploration of unmapped areas.

#### 33.2.4.8 Deep Learning

New extensions of ML research have been developed in the last years and since 2006, the term “deep learning”, also known as hierarchical learning or deep structured learning, has gained significant attention as a new prominent and promising area (Deng and Dong 2013) ever since researchers at the University of Toronto led by Hinton, at the University of Montreal led by Bengio, and at the University of New York led by Yann LeCun started popularizing this area (Bengio et al. 2016).

Periodically, deep learning is linked to a new generation of neural networks, because it has its foundations from artificial neural network research (Deng and Dong 2013). Substantially, when a neural network has more than two layers, it is considered deep (Heaton 2015). In fact, according to Bengio et al. (2016), while deep learning in artificial intelligence drawn its inspiration from neuroscience, the human brain and its neurons, current deep learning algorithms have been inspired not only from the neuroscience field, but also from structured probabilistic models and manifold learning.

Yann et al. (2015) suggest that deep learning can be understood as a multiple level representation of non-linear modules that mutate from a raw input level into a lightly more abstract level. In fact, the hierarchy of concepts, simpler concepts at the top of each other are built from more complicated ones, forming a deep graph with many layers (Bengio et al. 2016). In this way, a deep learning approach can learn more complex level representations and features based on a huge amount of unlabeled data (Zhao et al. 2017). Given that it is too complex for a computer to discriminate and understand raw sensory input data. Therefore, in the deep learning approach, the complexity of the model is solved by breaking it into simpler modules of data, described and represented by many different layers. Moreover, there is no need for human specification of knowledge, and therefore the computer solves more intuitive problems by learning through experience (Bengio et al. 2016). Several different components create a deep learning network. Currently, according to Brownlee (2016), the most known deep learning algorithms are:

*Deep Boltzmann Machine* (*DBM*): DBM is a hierarchical probabilistic model ramified from Markov random field (Salakhutdinov and Larochelle 2010). This model contains a set of multiple layers of visible units and hidden random variables (Salakhutdinov 2010) that demonstrate better performance to integrate uncertainty about ambiguous inputs (Salakhutdinov and Larochelle 2010). However, Salakhutdinov and Larochelle (2010) claim that when compared to Deep Beliefs Networks, DBM is not practical for huge datasets because it presents a slower performance.

*Deep Belief Networks (DBN):* According to Salakhutdinov and Murray (2008), Deep Belief Networks (DBN’s) are generative models that contain many layers of hidden variables. The main building block of a DBN is a restricted Boltzmann machine (RBM) due to which learning is intractable. Many application domains have benefited from DBN particularly in signal and information processing and other complex classifications.

*Convolutional Neural Network (CNN):* CNN can shift, scale, and distortion invariance to some extent, and therefore it can be applied in image segmentation, crowd density estimation and semantic relation classification. When presented with a huge number of examples of images, a CNN can adjust itself and learn from the training data (Huang and Zhang 2016). In fact, CNN used in Microsoft Research outperformed humans in identifying objects in digital image and so, CNN has been acclaimed as a prominent solution to image classification and other computer vision tasks that could be important for modeling service interactions between humans and machines (Huang and Zhang 2016).

In the last decade, the deep learning approach has been widely used not only for classification tasks and data mining, but also for dimensionality reduction and image processing. Indeed, as mentioned by Lewis (2016), companies such as Google, Facebook, Microsoft, Yahoo, Twitter and others use deep learning as a solution to understand better the market and offer desired products to clients based on their individual interests and preferences. Deep learning is the reason why the digital assistants in Siri, Alexa, and Cortana have improved substantially their understanding of human speech. A list of prominent fields where deep learning could be useful are Process Modeling and Control, Health Diagnostics, Investment Portfolio Management, Military Target Recognition, Analysis of MRI and X-rays, Credit Rating, Marketing campaigns, Voice Recognition, Stock Market Forecasting, Financial Fraud Detection, Character Recognition (Lewis 2016; Hsu 2016).

#### 33.2.4.9 Social Physics

The late 1990s work of Pentland at MIT (Pentland and Liu 1999) proposed that many human behaviors can be accurately described as a set of dynamic models sequenced together by a Markov chain. These dynamic Markov models can recognize human behaviors from sensory data and to predict human behaviors within a few seconds. However, as I described before, Markov chains are stochastic in nature and require that the probability of certain events or states be known, as the probability of each event depends on the state previously attained. In reality, human behavior is so random that the applicability of this approach to all human behaviors is questionable. Nevertheless, Markov chains have great appeal because they are memoryless, based only on the immediate prior event to forecast the next, and in this sense, could be mapped to the states of human behavior.

In 2014, Pentland published his Social Physics theory claiming that by studying simply patterns of information exchange in a social network (given the millions of observations produced by social media, cell phones, internet usage, etc.) one can produce a simple model of human behavior with great predictive power. The key to this approach is that without any knowledge of the actual content of the information one can gain useful knowledge about social groups of humans. If Pentland is right, one could argue that a deep understanding of behavioral and cognitive theories is not necessary to predict human states, but an attempt to integrate both is required to prove or disprove that hypothesis.

## 33.3 Future Research

Cyber-physical systems (CPS)[1] that are built from, and depend upon, the seamless integration of computational algorithms and physical components are increasingly "smart," that is, capable of actuation and reaction. Smart systems are becoming part of the makeup of society, enhancing interactions among people and with the surrounding environment. In this new "smart" context, people are not only users or operators of CPS in a closed-loop control sense, but are an integral part of the system as cognitive and social agents, providing data, receiving information, and affecting the physical and cyber realms. Inserting people into such systems may cause unexpected interactions, changing both the system and society. To engineer a truly adaptive system requires a design that is context-sensitive, intelligent, and self-adaptive, so that the physical and the cyber worlds synergistically interact and cooperatively evolve with the social world, at varying complexity scales in time and space and at different levels of aggregation. This introduces important new research and design challenges, leading to the next generation of collaborative human-centered engineered smart systems.

The hallmark of natural systems is that they involve variability across multiple scales of analysis, from neural and physiological, to cognitive, behavioral, and sociocultural. Devices must be able to harness and capitalize on this variability for fruitful interactions with humans to occur. Social interactions, interpersonal coordination and communication add another layer of complexity, resulting in nearly unbounded uncertainty when predicting long-term outcomes of these new engineered systems. Human variability in this sense should be seen as not just a source of noise and error, but also the source of incredible adaptability, flexibility, and innovation. The challenge is developing smart systems that capitalize on and respond to, or coordinate with, this variability, resulting in potential innovation as new service systems may emerge over the course of interaction with humans.

We are at a point in which new research in service systems must address partnerships between engineers and cognitive, behavioral, or social scientists to infuse what we know about people into engineered models. These teams should focus on essential knowledge that could lead to new paradigms. This work should translate human behavior, intentions, perception, preferences, cognition, values, culture, etc., into design frameworks and mathematical principles and new foundational architectures. Deep learning, Markov processes and agent-based modeling seem very promising as initial algorithmic frameworks to put on top of the data collected.

A key element of these needed research should be a focus on systems where teamwork or some sort of mutual interaction between system and human allows the system to deliver a service. A valid question is whether there are already disciplines and research fields working with such problems. Most notably, whether cognitive engineering or deep learning approaches cover the needed research.

[1] http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503286

There are more open than answered questions in this research space. For instance, human perceptions, intentions, feelings, and biases have not yet been fully modeled in mathematical terms, even though the field is certainly advancing thanks to Markov models, social network analysis, and deep learning. In the cases where they have been modeled, such as for service robots and other intelligent agents learning to interpret human gestures, language, etc., service system scientists have not yet incorporated those models to design and optimize a service system. Those modeling advances have not yet percolated to the idea of designing a service system where humans collaborate with intelligent machines, either as both human and machine service providers interacting with a service recipient or any combination of those. To design a service system where humans cooperate with machines, service scientists must recognize the need to consider human features in their designs and formulations that will then enable optimization.

There have been so far very few notable examples of service scientists taking modeling this step forward. Perhaps the most notable that of Das Gupta et al. (2016) who showed the use of two human cognitive traits or biases in the design of experiential services: memory decay and acclimation. They sequenced and timed the services to maximize the satisfaction of customers in an idealistic scenario just to demonstrate how psychological human traits can be used to design service encounters. The authors decided to use remembered utility functions and demonstrate the relationship of cognitive traits with satisfaction. They used the findings to tailor the design of the encounter in terms of a sequence of activities and time, focusing on maximizing (ex post) remembered utility, motivated by the prevailing evidence that people make decisions based on their memories of experiences. The reasons why these authors decided to focus on acclimation and memory decay are multiple and all related to the purpose of the paper as a demonstration of how human factors related to cognition and perception can be included in the optimization of service design. First, because of the strong empirical support for the form of the distribution of those traits in the psychology literature, which they needed for this exercise; second, these biases are sufficiently rich to explain classical empirical findings on remembered utility; third, the form of their distribution appear to be mathematically symmetric so that modeling them as a joint treatment was possible. According to these authors, the most prevalent models of memory decay are an exponential model and a power model. The optimal design maximized the gradient of service level near the end. They discovered that although memory decay and acclimation lead to the same design individually, they can act as opposing forces when considered jointly. Accordingly, they suggest that short service experiences should have activities scheduled as a crescendo and duration allocated primarily to the activities with the highest service levels, whereas long experiences should have activities scheduled in a U-shaped fashion and duration allocated primarily to activities with the lowest service level, to ensure a steep gradient at the end. This paper builds on the work of others who have introduced the idea of incorporating behavioral science considerations in service design (most notable Chase and Dasu 2001, and Karmarkar and Karmarkar 2014) who provided the basis for this mathematical extension. Recently, Adelman and Mersereau (2013) used dynamic programming to allocate scarce

resources considering how much customers remember their experience. One of the most important contributions of this paper is that it suggests a mathematical framework to include those human traits in the optimization of service design. While it does not design the interaction between humans and machines, it does design the service encounter. Extensions of this work could start to consider the optimal allocation of tasks when humans are improvising, creating, performing problem-solving tasks and machines are doing complex computations, repetitive, physically demanding or precise tasks.

### *33.3.1 Final Word*

To make progress putting people intelligently back into service systems requires convergence of behavioral science and cognitive science with mathematics, engineering, and computational sciences to translate theories of human behavior and create the necessary human state ontologies. Research findings from these areas need to feed those advancing sensing and actuation technologies. Service design studies of the optimal or effective allocation of tasks are needed. What task allocation is more efficient and effective and what distribution provides higher satisfaction to the customer? There is a nascent community focusing on these issues in computer science and engineering (e.g., deep learning, Markov-type of approaches, etc.), but very rarely are those research teams integrated with behavioral and cognitive scientists. Once some of the fundamental open questions are solved, it will be possible to tackle further challenges surrounding the design of smart human-engineered interaction for service system optimization.

**Acknowledgement** *Disclaimer*: Dr. Alexandra Medina-Borja was working at NSF while working on this chapter. Any opinion, finding, conclusions, and recommendations expressed in this paper are those of the author and do not necessarily reflect the views of the Foundation.

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# Chapter 34
# The Demolition of Service Scientists' Cultural-Boundaries

**Francesco Polese, Sergio Barile, Vincenzo Loia, and Luca Carrubbo**

**Abstract** More than 10 years ago, IBM launched Service Science as an open and aggregating initiative in an attempt to integrate different knowledge domains contributing to the study and better understanding of the dynamics of Service Systems and Smart Service Systems. Today, there are few published manuscripts that are effectively grounded in different knowledge domains. Moreover, in the fields of management and marketing, further investigation is needed to determine what are the effective contributes to scientific and theoretical advances in Service Science. This contribution to the second edition of the Service Science Handbook will detail the results of an investigation conducted through a bibliometric analysis of key scientific journals and books that, in their mission statements, have a clearly stated goal of reporting on advances in Service Science. It is demonstrated that the majority of the manuscripts seem to be grounded in vertical and specific scientific domains. Further, manuscripts produced by experts on management and marketing appear not to address models or theoretical propositions capable of advancing Service Science. Instead, these manuscripts are applicative and empirical studies, or they merely apply existing models or theories to specific Service Science issues or peculiarities. These findings should stimulate the growing Service Science community to improve the integration of the various scientific knowledge domains that are relevant to Service Science, to increase the number of co-authored articles by researchers with different interests, and to strongly promote scientific integration among scholars.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_34

**Keywords** Service science · Multi-disciplinarity · Cultural boundaries · Knowledge domain silos

## 34.1 Introduction

Service Science is a research initiative with fundamentally multi-cultural roots. Although they come from various and diversified disciplinary domains, service scientists seek a common terminology and language (Maglio and Spohrer 2008a, b). However, analysis of Service Science's output reveals that few contributions demonstrate intrinsic multi-disciplinarity in their content, development and references and that additional interdisciplinary work is needed. Indeed, we believe that the cultural boundaries affecting service scientists usually trap them—often unconsciously—within their disciplinary silos. For this reason, we wish to quantitatively analyze the extent to which Service Science manuscripts are characterized by interdisciplinarity. This analysis does have some weaknesses, given the difficulty of identifying the clear scientific positioning of articles and authors, as well as the undoubtedly fuzzy boundaries of any scientific field of interest, and particularly of Service Science.

Even though we agree that 'careful attempts to compare comprehensive reference models of service will provide an important contribution to the development of service science' (Alter 2012), we are also convinced that the future of Service Science will require a stronger and more efficient use of multi-cultural approaches and discussions if the interdisciplinary essence of Service Science is to be fully realized. Here, we use the terms multidisciplinary and multi-domain as synonymous, but we do not consider culture, multi-culturality and multi-cultural approaches to be the same concepts as the previous two, since these latter three are much broader and certainly different.

We believe that the Service Science community, in striving to better achieve its challenging goals, must go far beyond the knowledge silos and vertical knowledge that have traditionally characterized scientists' backgrounds and studies. With this aim, we will investigate the following research questions:

RQ1: to what extent do service scientists principally recognized within a specific cultural domain—in this case, management and marketing—valorize (and refer to) other studies from different knowledge domains?

RQ2: to what extent are management and marketing scientists contributing to scientific and theoretical advances in service science?

As far as RQ1 is concerned, we assume that it is possible to attribute to any researcher a prevailing cultural background and cultural field of interest. This is not always true, and such attribution can sometimes be difficult, but for the purpose of this study, we believe it can be done. Moreover, the prevailing scientific positioning and references of a manuscript are not always discernible, and sometimes the interpretation of a manuscript may be affected by the subjective views of the analyst. Despite these difficulties, we believe that the attempt to pursue this analysis is

nonetheless valuable. We have pointed to contributions addressing management and marketing, but of course we could have addressed any other cultural domain, as other options are equally significant.

As far as RQ2 is concerned, the following analysis will try to deepen our understanding of the extent to which the contributions of management and marketing have a transversal focus capable of advancing Service Science as a theory. We also investigate how many of these manuscripts present vertical and empirical approaches to specific themes and sub-themes that impact the main goals of Service Science.

## 34.2 Service Science Manifesto: A Call for Multi-disciplinarity

'During its infancy as a new discipline, there is nothing wrong with treating service science as an umbrella term encompassing everything that has the term service in its name' (Alter 2012, p.23). Accordingly, the Service Science community has attracted scientists from many cultural domains, united by their interest in contributing to a better understanding and knowledge of the service-centered and service-oriented phenomena that characterize our lives just as much as socio-economic actors (Katzan 2008).

With this scope, Service Scientists have, since the beginning of Service Science, come from different backgrounds, including engineering, computer science, management, psychology, business, marketing, IT, organization, and law (Demirkan et al. 2011a, b). Service Science has been based upon a strong multi-disciplinarity and has aimed to improve, through its various contributions, the understanding and management of the complex phenomena characterizing the planet and its major issues today (Basole and Rouse 2008). Ultimately, the Service Science community has addressed both the theorization and practical understanding of 'service systems', looking for contributions that are capable of better designing and managing such systems and their related value co-creation processes (Maglio et al. 2010).

This *leitmotif* has been clear since the early scientific debates of the Service Science community. In 2007, at the IfM IBM Cambridge Symposium, for instance, many scholars argued that Service Science was emerging as a distinct field that, if it is to study service systems, must be based upon many different disciplines, given that its vision is to discover the underlying logic of the dynamics of service systems and to establish a common language and shared frameworks for interpretative models in service (IfM and IBM 2008). To this end, an interdisciplinary approach should be adopted. Given the final goal of Service Science, its approach creates bridges between disciplines by taking on grand research challenges and by working with practitioners to create data sets and simulation tools to understand the nature and behavior of service systems (Qiu 2009).

This multi-disciplinarity has never been underestimated; it has also been underlined in the first Service Science Handbook, which proposes how Service Science is an inter-disciplinary approach to studying, improving, creating and innovating in service.

Giving service scientists the opportunity to integrate different knowledge domains enriches their interpretative models and seems to be a wise way to address the complexity and dynamism characterizing business and social contexts today (Ng et al. 2009; De Santo et al. 2011). For these reasons, the discipline of Service Science, Management, Engineering and Design (SSMED) is inherently based on reflections derived from engineering, computer science, sociology, design, law, philosophy, ecology, management and marketing (Spohrer and Kwan 2009). This is perfectly consistent with the call for interdisciplinarity in the study of Smart Service Systems (Barile and Polese 2010a, 2010b). Indeed, in many fields of interest, Smart Service Systems powerfully describe many features of devices such as smartphones, smart-grids, and smart-boxes. Moreover, we can observe the diversity of applications of Smart Service Systems because we can find Smart Service Systems in so many sectors (Healthcare, Tourism, Energy, Education, Retail, Logistics and ICT). The attention paid to Smart Service Systems by every player in the market has increased the relevance of Smart Service Systems in the economy as a whole. Progress in a variety of technologies (not only in computer science) bridges this evolution. Furthermore, advances in Smart Service Systems have enhanced the shared vocabulary among disciplines; this shared vocabulary is one of the main goals of the development of a unified Service Science (Spohrer et al. 2007), which should connect different perspectives on Smart Service Systems, including data collection, analytics, and information delivery (Maglio et al. 2006). In this sense, the intelligence of Smart Service Systems is derived not from intuition or chance but from systemic methods of learning, service thinking, rational actions, social responsibility and networked governance (Mele and Polese 2011; Barile et al. 2012), all of which are principally based upon a multi-disciplinary approach to understanding service exchanges (reality) (Vargo and Lusch 2016).

According to IBM's official website, since 2006, we have known that the mission of the Service Science Professional Interest Community (PIC) is to stimulate this cross-disciplinary research and provide a forum within the IBM Research community for the study of theory, methods and applications.

From the recent debates of the Smarter Planet Forum concerning programs at US universities (https://www-03.ibm.com), we know that while Service Scientists can benefit from a multi-disciplinary perspective, making a Smarter Planet mandates the adoption of such a perspective. Service Scientists, therefore, are now attempting to leverage their work by helping universities to develop their Service Science programs into Smarter Planet 'Research Centers' and 'Think Labs'.

According to this scientific positioning, Service Science has been promoted worldwide through higher education and MBA programs based upon a T-Shaped mindset that proposes vertical knowledge coupled with, and supported by, transversal and general knowledge (Demirkan and Spohrer 2015).

This call for multi-disciplinarity was recently confirmed at the last Editorial Board Meeting of the Service Science journal held in November 2016, during which it was agreed that Service Scientists aim to publish innovative and original papers on all topics related to service, including work that crosses traditional disciplinary boundaries.

## 34.3 Service Scientists' Fields of Interest

The historical evolution of the scientific pillars of Service Science can be traced by highlighting three main fields—Social Organization, Business and Technology—as cited by Maglio and Spohrer; see Fig. 34.1.

Building upon these cultural pillars, Service Scientists have introduced ten Fundamental Concepts (i.e., Resources, Entities, Access Rights, Value co-creation interactions, Governance interactions, Outcomes, Stakeholders, Measures, Networks, Ecology) that, indeed, are multi-disciplinary in their content, focus and lexicon (Spohrer et al. 2008). A further attempt to identify the various disciplines engaged in the promotion and development of Service Science was part of the proposal of a specific set of Service Science areas of interest based upon the four constituents of Service Systems, namely Shared Information, People, Organization and Technology; see Table 34.1 below.

The above Table is particularly interesting where it addresses specific tasks related to specific scientific areas of interest, but it reveals itself to be very limited as the level of abstraction grows. In other words, the cited areas of vertical knowledge are all basic elements of the Service Science scientific puzzle, but they ought to

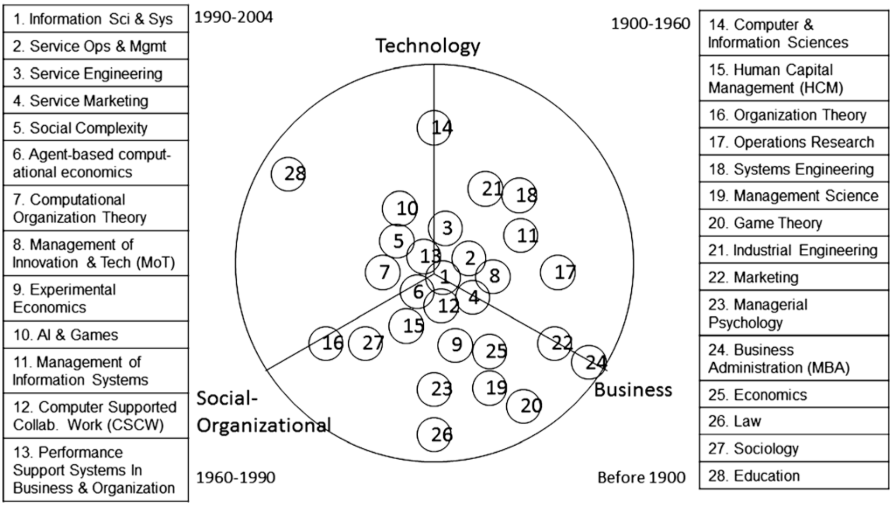


**Fig. 34.1** Basic principles of Service Science (Maglio and Spohrer 2008c)

**Table 34.1** Service science areas of interest (Maglio and Spohrer 2008a)

| Organizations | Technology | People | Information |
|---|---|---|---|
| Systems thinking | Industrial engineering | Consumer behavior analysis | Communication |
| Business management | Informatics | Cognitive science | Information systems management |
| Supply chain management | Statistical control | Sociology | Reporting |
| Innovation management | Mathematics | Psychology | Processes and models |
| Resource management | Physics | Political science | Design |
| Marketing | Cybernetics | Plan and project | Simulations |
| Program and control | Neural nets | Human sciences | e-Learning |

be seen as blurred and fuzzy every time Service Scientists look for Service Science advances because they should imply the overcoming of cultural silos (Halonen et al. 2010). Scientific production conducted within our service science community, in other words, might be characterized by the low impact of its scientifically integrated manuscripts, the majority of which, indeed, seem to rest upon vertical and specific scientific domains.

One of the major scientific fields relevant to Service Science is that of management and marketing, which indeed contribute to many vertical and transversal Service Science issues. Managerial studies, in fact, significantly contribute to the promotion of productivity, quality, performance and improvements in Service Systems by defining and organizing the context for effective and sustainable value co-creation exchanges (Mele et al. 2010; Gummesson et al. 2010; Badinelli et al. 2012, Wieland et al. 2012).

With this awareness, but at the same time being conscious that many other choices might have been equally significant, the following quantitative analysis will focus on the deepening of management and marketing contributions to Service Science.

## 34.4 Management and Marketing Contribute to Service Science Advances

In this section, we wish to deepen our understanding of management and marketing contributions to Service Science, with the specific goal of addressing the two research questions proposed in this chapter.

In order to proceed with the analysis, we have looked for Service Science contributions published in key scientific journals and books that, in their mission statements, clearly state the goal of reporting on advances in Service Science. After identifying three journals and the first edition of the Handbook of Service Science as

particularly significant to the service science community (regardless of the numerous other scientific publications in other journals), the analysis was conducted using manuscripts from the first issue, published in early 2009, through those published in December 2016. The above-defined body of research includes manuscripts whose scientific fulcrum gravitates from computer science to organization sciences, from IT to engineering, from consumer behavior to service design, and so on. This set of manuscripts was analyzed critically, looking for contributions that proposed advances from a management and marketing perspective. The selected journals were the following: Service Science, published by INFORMS.

INFORMS recently confirmed that Service Scientists aim to carve out a unique niche among service-related journals. Its main objects of study are services, activities and technologies that create value through the interaction of multiple stakeholders and for the benefit of multiple stakeholders. Service Scientists publish empirical, modeling, and theoretical studies of service systems. Capturing the basic and applied knowledge needed to enable the future of smart, human-centered service systems is the mission of Service Science.

Journal of Service Science Research (JoSS), published by Springer and promoted by the Society of Service Science.

From the last call for papers in the Journal of Service Science Research in 2016, we learned that the journal aims to promote the advancement of knowledge in the field of service science and to offer an integrated view of the field by presenting the approaches of multiple disciplines. Topics include, but are not limited to, Service science theory, Service economy, Service management, Service design, Service systems, Service engineering, Industry practice, Service science education, and related subjects such as Business & Management, Industrial Organization, Production & Process Engineering and Software Engineering.

International Journal of Service Science Management Engineering and Technology (IJSSMET), published by IGI Global.

Based on the most recent presentation of the International Journal of Service Science, Management, Engineering, and Technology (IJSSMET) in 2016, we know that it is a multi-disciplinary journal that publishes high-quality and significant research in all fields of computer science, information technology, software engineering, soft computing, computational intelligence, operations research, management science, marketing, applied mathematics, statistics, policy analysis, economics, natural sciences, medicine, and psychology, among others. This journal publishes original articles, reviews, technical reports, patent alerts, and case studies on the latest innovative findings of new methodologies and techniques.

In addition to manuscripts published in these three journals, in the analysis chapters of the three volumes published within the Handbook of Service Science, The Science of Service Systems and Service Systems Implementation, published by Springer in 2010 and 2011, were also included.

Each manuscript was analyzed in order to identify those studies whose principal investigation was rooted within management and marketing studies with respect to arguments, citations, scientific propositions, lexicons, and models. An attempt to report on multi-cultural approaches to scientific advancement is listed in

**Table 34.2** Bibliometric analysis

| Journal/book | Total manuscripts (A) | Manuscript on management (B) | Multiculturality RQ1 (C) | High perspective RQ2 (D) |
|---|---|---|---|---|
| IJSSMET | 115 | 18 | 3 | 2 |
| JoSS | 50 | 12 | 2 | 1 |
| Service Science | 225 | 46 | 10 | 3 |
| *Tot. journals* | *390* | *76* | *15* | *6* |
| Handbook of Service Science | 31 | 9 | 3 | 2 |
| The Science of Service Science | 17 | 4 | 2 | 1 |
| Service Systems Implementation | 17 | 2 | 1 | 0 |
| *Tot. books* | *65* | *16* | *7* | *3* |
| **Tot.** | **455** | **91** | **21** | **9** |

Our elaboration

**Table 34.3** Remarks

| Journal/book | Population B/A | Incidence RQ1 C/B | Incidence RQ2 D/B |
|---|---|---|---|
| IJSSMET | 15.65% | 16.67% | 11.11% |
| JoSS | 24.00% | 16.67% | 8.33% |
| Service Science | 20.44% | 21.74% | 6.52% |
| *Tot. journals* | *19.49%* | *19.74%* | *7.89%* |
| Handbook of Service Science | 29.03% | 33.33% | 22.22% |
| The Science of Service Science | 23.53% | 50.00% | 25.00% |
| Service Systems Implementation | 11.76% | 50.00% | 0.00% |
| *Tot. books* | *23.08%* | *40.00%* | *20.00%* |
| **Tot.** | **20.00%** | **23.08%** | **9.89%** |

Our elaboration

Table 34.2—column (B), in which articles with at least two cultural domains (as based upon arguments, citations, lexicons, etc.) were included. Manuscripts demonstrating a higher level of abstraction and arguments were reported in Table 34.2—column (D).

Analytics and remarks are detailed as follows, cfr. Tables 34.2 and 34.3.

As far as the two research questions are concerned, we find a significant proportion of manuscripts whose main focus is on management and marketing (approximately 20% of total manuscripts). However, if we analyze their content, we find that only a few of them appear to be multi-culturally based (RQ1, approximately 23%) and, in addition, only a few of them use a scientific approach with a multidisciplinary perspective (RQ2, approximately 10%).

The majority of the manuscripts proposed by experts on management and marketing within the Service Science community, in fact, do not address models or

theoretical propositions capable of advancing Service Science but are instead applicative and empirical studies, or they merely apply existing models or theories to specific Service Science issues or peculiarities.

These results, which are unfortunately predictable to some extent, demonstrate how the contributions of management and marketing scholars are indeed vertical and that these researchers scarcely contribute to the intrinsic mission of Service Science's multi-culturality.

We were not able to conduct the same analysis of other cultural domains, and this is left to our future investigations. Nevertheless, we observe that management and marketing are usually considered transversal knowledge domains that usually focus on topics of wide and common interest. If these manuscripts highlight the weakness cited above (i.e., a lack of multi-culturality), we are concerned that this trait may be even more pronounced in other scientific areas. It seems that knowledge silos are present and that researchers face difficulties in pursuing the mission and scope of Service Science, which is to overcome cultural boundaries and traps. Young Service Scientists, who have grown up within T-shaped programs, will probably contribute significantly to resolving this criticality in the coming decades. Meanwhile, because we cannot afford to wait so long, our community should target its efforts according to the cornerstones of our future research paradigms.

## 34.5 Implications for Researchers and the Service Science Community

The analysis presented here does have certain limitations and is influenced by our chosen perspective; moreover, the results are conditioned by the sometimes-uncertain boundaries of knowledge domains, which can make it difficult to clearly position a manuscript proposal. Nevertheless, the attempt to evaluate the multi-culturality of the Service Science community remains a stimulating and valid endeavor, and for this reason, the outcomes of this analysis should guide Service Scientists in their future research efforts. Service Scientists ought to overcome the constraints and limits of each single discipline through the demolition of their own cultural boundaries, thus enabling a wider research perspective and producing intriguing results in terms of scientific advances. The demolition of cultural boundaries can strongly support the generation of applicative research capable of advancing Service Science in numerous domains.

The variety of Service Scientists' backgrounds is—definitively—the real strength of Service Science. However, individuals' scientific inertia may inhibit the fulfillment of the final goals of Service Science. The demolition of cultural boundaries and the gradual evolution of our community, therefore, should be inclined towards a multi-cultural approach that positively affects the scientific propositions of our field, thanks to the following strengths: the asset of co-authorship, reflecting the participation of different cultural domains in the same article; multi-cultural approaches to

article development, with regard to both the exposition of the content and the references at the core of the article's design and conception; a curious approach by reviewers capable of celebrating—not inhibiting—multi-cultural approaches to scientific advances (regardless of their scientific background); the promotion of cultural events capable of attracting scholars from a variety of backgrounds.

At the top of our to do list, it seems necessary for the editorial missions of journals in the Service Science community to foster both the effective demolition of cultural boundaries and an even more multi-cultural celebration of contributions; this mission should be pursued by wise journal editors capable of interpreting this challenging task. Knowledge silos are comfortable, but they are traps for scientific advancement (Larson 2016). Thus, we strongly believe that we need to abandon these comfortable positions and challenge our ideas by adopting original and multicultural approaches.

Future Service Scientists will receive and be part of a valuable and updated multidisciplinary educational program, thus valorizing a multi-cultural approach. Nevertheless, our efforts ought to be directed towards the rise and establishment of this new generation of researchers.

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# Chapter 35
# Asset-Based Strategies for Capturing Value in the Service Economy

**Jochen Wirtz and Michael Ehret**

**Abstract** In advanced service economies, almost any activity, skill, and asset can be bought on competitive markets, making it increasingly difficult to build competitive advantage on any of those inputs. Therefore, firms have to carefully decide what to own in order to capture value. That is, firms have to explore what types of assets can add value to their customers and at the same time are difficult or illegal to copy by competition. We examined this question and identified asset categories that potentially allow a firm to appropriate value. They are (1) resource-based assets (e.g., proprietary equipment and systems, manufacturing-related intellectual property (IP), and social capital with employees); (2) platform-based assets (e.g., physical and intellectual platform assets, and critical mass and volume-based advantages); and (3) market-based assets (e.g., brands and related brand equity, physical and virtual points-of-sale, access to physical and virtual distribution networks, and customer information and loyalty programs). Furthermore, we propose that each of these three asset categories can take the form of three types of capital. They are (1) tangible capital (i.e., it has a physical manifestation such as equipment and physical points-of-sale); (2) intangible capital (i.e., it can be codified and legally protected such as patents and brands); and (3) social capital (i.e., it is embedded in people's minds and cannot be legally protected such as trust, goodwill and engagement of employees,

This article draws on and extends the following publications: Michael Ehret and Jochen Wirtz (2018), Ownership of Cocreation Assets: Driving B2B Value Propositions in the Service Economy. *Journal of Creating Value*, 4(1), pp. 42–60, https://dx.doi.org/10.1177/2394964318772146 in print), "Ownership of Cocreation Assets: Driving B2B Value Propositions in the Service Economy," *Journal of Creating Value*; and Jochen Wirtz and Michael Ehret (2017), "Capturing Value in the Service Economy", *Journal of Service Management Research*, 1(1), pp. 22–38.

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_35

partners and customers). The three asset types and their three manifestations are integrated into a framework for an asset typology. For example, market-based assets can come in all three forms, that is in tangible (e.g., point-of-sale networks), intangible (e.g., brands), and social (e.g., customer equity) form. Finally, we identified four important organizational capabilities of asset integration that are independent of asset ownership but effectively link owned and outsources assets, capabilities, and processes to value creation and can also allow a firm to capture value. They are (1) business models for designing the architecture and "Gestalt" of value creation; (2) a customer-centric culture and a climate for service; (3) innovation capabilities, and (4) the effective management of an integrated web of processes and activities. We discuss the why and how of this asset typology and its implications for management, strategy, and research.

**Keywords** Service economy · Competitive advantage · Competitive strategy · Asset ownership · Capturing value · Value appropriation

## 35.1 The Rise of Service Business Models and Reconfiguration of Value Chains

One of the most striking economic phenomena is that the services sector becomes dominant as an economy develops (Buera and Kaboski 2012). Contrary to common belief, economic statistics show that the share of consumer services does not show significant shifts. In fact, in the US the share of consumer services of GDP has remained largely unchanged over time. Rather, it is business services such as finance, logistics, IT services and consulting, that lead the expansion of the service-sector (Ehret and Wirtz 2010; Ndubisi et al. 2016; OECD 2007; Triplett and Bosworth 2003) and are the key motor behind the growth of the service sector (OECD 2007; Woelfl 2005). Debates of the service economy have ignored for too long that innovation and restructuring of business services work as the main driver of economic growth (Ehret and Wirtz 2010; OECD 2007; Wirtz et al. 2015; Woelfl 2005).

In advanced service economies, almost any activity can be hired as a service (see Fig. 35.1). A broad range of business functions once deemed as mandatory for in-house control are increasingly outsourced. For example, a firm's strategy might be developed by independent consulting companies or even venture capital firms, research and development (R&D) delegated to external firms, and a substantial extent of the competitiveness of current offerings may reside on the performance of externally-provided supply chains, IT-services and customer contact centers. In fact, the firms offering such services are often unbeatable by in-house departments in terms of their performance, quality, cost of operations, and innovation capability (Ehret and Wirtz 2010; Wirtz et al. 2015).

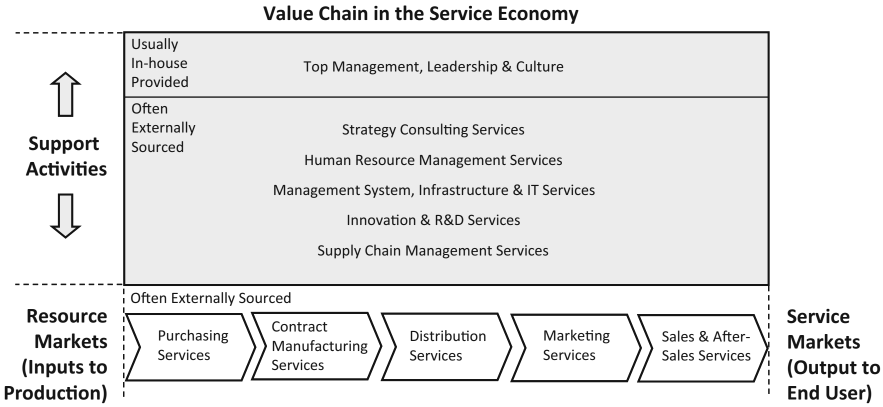


**Fig. 35.1** Value chain in a modern service economy where most assets, activities, and skills can be outsourced

This almost wholesale shift towards a service economy has dramatic implications for strategic management. If almost any asset, activity and skill can be outsourced to high-performing external service providers, what should a company focus on and assume ownership over to build a competitive advantage and to be able to capture value? In this article, we address these questions by presenting business model approaches for re-configuring value chains, discussing the role of specific asset types for value appropriation, and explaining management approaches that might offer potential for developing a competitive edge.

## 35.2 Service Business Models and Asset Ownership

Industry-driven competitive strategies build on a given structure of established roles like those of upstream suppliers, downstream customers, and distribution channels, as well as competitors and substituting technologies (e.g., Porter 1980). However, service economies are driven by structural shifts and when faced with shifting industry structures, these strategies lose their point of reference. Business model approaches aim to fill this void and offer a dynamic view of hypercompetitive ecosystems that contrast with the industry structure perspective underlying Porter's value chain (Stabell and Fjeldstad 1998; Zott and Amit 2008).

In a service business model, firms deliver benefits without the transfer of ownership (Wirtz and Lovelock 2016, p. 21). Transfer of ownership marks a crucial difference between a goods business, where suppliers transfer ownership of assets like cars or machines to their customers, and service business where providers deliver results to their clients, like transportation to a required location, or uptime and output of a manufacturing line without transferring ownership (Chesbrough 2011; Ehret and Wirtz 2010; Lovelock and Gummesson 2004; Wittkowski et al. 2013).

For providers and their clients, service business models have been opening new pathways for value creation, whereby clients are relieved from the need to own and operate assets. As service clients replace in-house assets and activities with purchasing services, this outsourcing offers opportunities for service providers who specialize in managing the resource base (Ehret and Wirtz 2017, 2018).

Service research shows rationale and evidence that service business models deliver benefits from non-ownership for providers, their clients, and the overall economy through productivity gains (Chesbrough 2011; Lovelock and Gummesson 2004; Wittkowski et al. 2013). To date, the focus of service research on non-ownership value has been on the service client's perspective (Lovelock and Gummesson 2004), understanding intentions to purchase non-ownership services (e.g., Wittkowski et al. 2013), and addressing its underlying economic rationale (Ehret and Wirtz 2010, 2017). In that light, it is tempting to view ownership as a burden that bears little value. However, the fast growth of non-ownership services does not mean that ownership disappears. Rather, both managers and researchers have yet to face the supply-side implications of non-ownership in terms of both opportunities and burdens for providers. Thus, strategy research needs to take a deeper look into the conditions that render asset ownership as building block for long-term competitive advantage. In the following section, we take a closer look at the role of assets in value creation and appropriation.

## 35.3 Assets for Value Appropriation

Service economies put firms under a severe dilemma. As almost any business function, operation or activity becomes available as a service, firms are gaining flexibility and ease of access to resources (Ehret and Wirtz 2010; Quinn 1992). This boon of resources comes with a flip-side that potentially undermines the economic legitimacy of a firm. That is, when assets, resources, and capabilities under control by the firm are easily substituted by competitors, building sustainable competitive advantage becomes even more challenging. Firms need to scrutinize if their assets connect them to opportunities or rather work as baggage for the firm. Thus, the challenge for identifying competitive grades of vertical integration shifts from transaction cost efficiency towards opportunities and their implications for asset ownership (Ehret and Wirtz 2010).

In short, to support value appropriation, firms need to own assets that create value for their clients that cannot be copied, take a long time to copy, or are illegal to copy. In this article, we explore how and when key asset types can potentially be the basis for sustainable competitive advantage in advanced service economies.

## 35.4 Asset Types in Value Co-creation

While several authors accentuate the supply-driven aspect of the resource-base, its pioneers see resources as crucial links between firms and entrepreneurial opportunities on external markets (Lewin 1999; Penrose 1959). This view finds its echo in the work of researchers who have established the resource-based view as one of the major conceptual foundations of the marketing domain (Morgan and Hunt 1994; Wernerfelt 1984).

Entrepreneurial opportunities are key drivers of resource rents and emerge when customer needs are not addressed or resource potential remains idle (Alvarez et al. 2013; Amit & Schoemaker 1993; Kirzner 1997; Shane and Venkataraman 2000). Under equilibrium, assets can easily be substituted, pushing firms in the position of price takers. Business opportunities are neither objectively nor intrinsically given but emerge through the relation between the needs of customers and the capabilities of the resource-base to serve them. The value of a resource is driven by the relation between its intrinsic capabilities and extrinsic user needs. The key criterion for judging the value of a resource is its potential of being transformed into goods and services that render value-in-use (MacDonald et al. 2016; Vargo and Lusch 2014).

By considering the potential role of transforming resources into user value, we can differentiate between three basic asset categories (see Fig. 35.2). First, market-based assets enable a firm to identify needs, craft product offerings that match identified needs, specify contracts for organizing transactions, and deliver the goods and services. Basic forms of market based-assets include brands and the related brand equity, customer equity, communications channels, and points of sale. Second, resource-based assets relate to capabilities and capacity of production. Basic forms of resource-based assets include equipment, systems, facilities, and manufacturing-related IP. Third, platform-based assets include physical platforms (e.g., a market place and strategic real estate), virtual platforms (e.g., an electronic market place), which both are frequently protected through network effects and enabled through critical mass or liquidity.

For each of these assets, we can identify three basic manifestations or types of capital, namely tangible (or physical), intangible and social capital. First, tangible capital has a physical manifestation and entails assets like equipment, facilities, and points-of-sale (POS) that provide the material basis for differentiating products and their delivery. Such assets play key roles in each stage of the value chain, including setting the scene at the point of customer interaction, in production, and through the physical platforms that connect resources and customers.

Second, intangible capital consists of ideas, knowledge or information that does not have a physical manifestation but is legally protected. At the front end, brands shape the perception and image of products while resource-based IP enhances technological capabilities of production, and platforms entail a growing range of intellectual capital.

Third, social capital, such as trust, goodwill, and engagement of employees, partners, and customers, cannot be legally owned by a firm, which renders it even

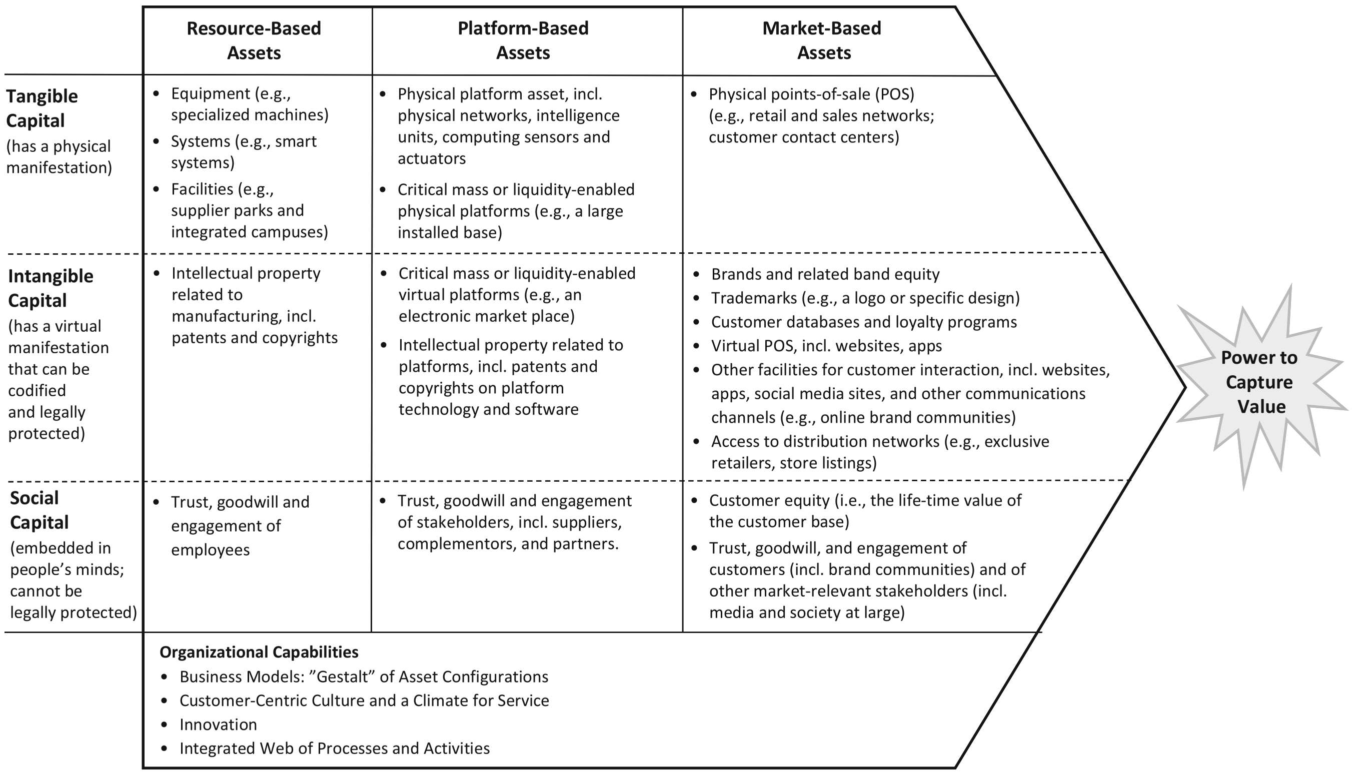


**Fig. 35.2** Assets and capabilities that enable capturing value in the service economy. Adapted from Wirtz and Ehret (2017)

more precious. Social capital takes the form of human resources and organizational culture and climate in the domain of the provider, platform assets mainly in the form of trust, goodwill and engagement of suppliers, partners, and complementors, and not least in customer engagement which constitute market-based social capital. Because owners are responsible for up- as well as downsides of their asset-base, a selective approach to asset-ownership is critical, and firms need to prioritize on those assets where they can hope to make the highest contribution to their clients.

Finally, we identified four important organizational capabilities of asset integration that are independent of asset ownership but effectively link owned and outsources assets, capabilities, and processes to value creation and can also allow a firm to capture value. They are (1) business models for designing the architecture and "Gestalt" of value creation; (2) a customer-centric culture and a climate for service; (3) innovation capabilities, and (4) the effective management of an integrated web of processes and activities. We discuss next each of the asset categories.

We discuss next the why and how of this asset typology and its implications for management, strategy, and research.

## 35.5 Resource-Based Assets

Resource-based assets represent capabilities and capacity of the supply base. One driver of service businesses is the value proposition offered by non-ownership: Clients can get the benefits from resources without the burdens of ownership. The challenge for providers is to bear the ownership of resources as an entry-gate to opportunities. Downsides of ownership do not simply disappear because of a re-allocation of asset ownership from one firm to another. Thus, providers need to identify smart ways to bear ownership. Specialization in the management of a particular asset class can offer trajectories for service providers that are out of reach for vertically integrated companies. By specializing on particular types of resources, providers can gain unique positions, differentiate assets, drive cost advantages, and also gain economies of scale and scope, for example, by furnishing general purpose resources across entire industries if not economies.

### *35.5.1 Resource-Based Tangible Capital: Equipment, Systems, and Facilities*

Equipment, systems, and facilities define the capabilities and capacity of a service, providing clout for companies that design, own and operate them. Asset-ownership offers an entrance gate for establishing service and solution businesses for plant, machine, and equipment manufacturers (Ehret and Wirtz 2017). For example, in the domain of industrial production, suppliers have been moving towards owning and

operating equipment, machines and even entire plants on behalf of their customers. Examples include chemical company BASF which has been moving to operate its clients' automotive paint shops (Worm et al. 2017), and Rolls Royce commercialized airplane engine services through "power-by-the-hour" contracts. In such performance and solution schemes, providers earn revenue on the output and the benefits generated by industrial assets rather than through selling the assets themselves (Ehret and Wirtz 2017). While relieving their customers from risks associated with industrial assets, these risks remain with the service providers. However, providers who specialize on asset management can build superior experience and resources that empower them to better mitigate and bear uncertainties compared to their clients. They can succeed by building and maintaining an in-depth understanding of the equipment and technology, and a much larger installed base that allows them to invest in smart systems that enable better quality and more cost-effective operation of equipment and its maintenance and repair (incl. preemptive maintenance and other innovative services based on based on AI, big data, and analytics; Ehret and Wirtz 2017). Such integrated solutions, smart systems and taking on risk are much more difficult to copy by competition than individual pieces of equipment and therefore more likely to help develop a competitive edge.

### *35.5.2 Resource-Based Intangible Capital: Patents and Copyrights*

Technology represents human knowledge of resource potential and is driving the performance of services, as is evident in the dramatic extension of performance frontiers in key areas such as transportation, communication, manufacturing, and health. If technological knowledge can be made explicit it can be legally protected and become an intellectual asset, such as a patent or a copy right. IP can be a powerful source of competitive advantage. In fact, one of the striking features of the service economy is its opening up of opportunities for science-based businesses upstream that aim to make intellectual capital creation their main source of revenue. In turn, downstream companies prioritize investments into market-based assets, like the pharmaceutical industry, that specialize in turning patented ideas and technologies into real-world products (Mock 2005). Whether IP is owned by a specialized research firm or by the company delivering the final product to their clients, IP can be a powerful source of competitive advantage.

### *35.5.3 Resource-Based Social Capital: Engaged Employees*

People make the crucial difference to any asset and organization as a whole as people are the key to a firm's level of customer centricity and they are holders of tacit

knowledge. In contrast to material or intellectual assets, people have agency as well as human capabilities and traits like empathy, communication, and creativity. A substantial share of such knowledge is tacit and defies encoding and is therefore embedded in the company's people, resources and routines which makes it hard to copy (Pisano and Teece 2007).

The quality of an organization's people is crucial for its market success and financial performance. Employees have the power to breathe life into assets, energize processes, and make the difference by their efforts to understand customer needs and expectations, as well as delivering the performance and productivity that eventually lead to high service quality, customer satisfaction and loyalty (Bowen and Schneider 2014; Wirtz and Jerger 2017; Subramony et al. 2017). However, boundary-spanning frontline jobs are challenging, they often come with role conflict and emotional labour (Wirtz and Jerger 2017). Successful organizations address those challenges and are committed to the effective management of human resources, including best practices related to recruitment, training, empowerment, service delivery teams, employee motivation, and creating a strong service culture, climate, and effective service leadership (Wirtz and Jerger 2017). Excellent HR strategies with strong service leadership often result in a sustainable competitive advantage as it seems harder to duplicate high-performing human assets than any other corporate resource (Wirtz and Lovelock 2016, p. 443).

## 35.6 Platform-Based Assets

Most basic services are probably as old as humanity. Long before the dawn of the industrial age, people have offered bed and breakfast, transportation, dining, education and much more. What is usually identified as the rise of the service economy does not necessarily indicate revolutionary new types of offerings but a re-organization of value creation processes (Ehret and Wirtz 2010). The rise of infrastructure technologies, namely IT and transportation services offers new means for transforming resources into services. Infrastructure technologies often unlock the physical location of service provision from the location of its use and experience. Such service platforms serve primarily the interaction between resource owners and service users. By offering virtually universal access, platforms drive scale and liquidity through increasing and consolidating relevant markets (Chesbrough 2011; Parker et al. 2016, 2017; Rifkin 2014).

We define platforms as configurations of assets that connect resource owners with service users. As for resources, we propose three essential types of platform-based assets: (a) Tangible network capital establishing physical connections between resource owners and resource users; (b) Intangible platform assets build liquidity-enabled virtual platforms, and on technology and software, and (c) Social capital formed of social relationships that facilitates interaction and cocreation between key platform stakeholders. We discuss these in turn.

### 35.6.1 Platform-Based Tangible Capital: Physical Platforms and Critical Mass

Physical network capital establishes physical connections between resource owners and service users. Basic elements of physical network capital are communication networks most notably the internet and other communication interfaces that connect resource owners and service users. Key elements of such interfaces are sensors that provide real-time information about a service, like the operation of a machine or device, as well as actuators that execute an effect directed through communication networks, like the control of a machine or a drone. Not least, physical network capital resides on intelligence units equipped with data storage and computing power for controlling and directing services (Andersson and Mattson 2015; Ehret and Wirtz 2017; Geisberg and Broy 2015).

By opening up almost universal access to resource owners and service users, physical platform capital constituting the physical backbone of the internet has dramatically increased scale and liquidity of services, offering the critical mass justifying investments into innovative service offerings. In the domain of consumer services like accommodation, car sharing or ride haling, the rise of the sharing economy has made this apparent (Chesbrough 2011).

Let us illustrate the key economic mechanism at work in physical network capital with the example of a prominent industrial service—the “Power-by-the-Hour”--service offered by airplane engine manufacturer Rolls Royce (Ehret and Wirtz 2017). Instead of buying airplane engines, airlines have been shifting to service models by delegating ownership to service manufacturers who earn revenues only for those hours where the airplane is effective in operation. Thereby, airlines shift a substantial share of the financial risk related to the operation of an airplane to the service provider. Relieved from technical operations, airline management can focus on downstream opportunities, exploring the potential for attractive destinations, requirements for customer service, network extension and brand equity. Striving to succeed in attracting and serving passengers, airline managers appreciate shifting some responsibility to a service provider as well offer providers a self-enforcing incentive justifying investments into safety standards and availability of engines. As the service provider, Rolls Royce gets access to a continuous stream of service revenue and it has the clout to capture the financial value for effective service operation as well as efficiency improvements.

Physical network assets are key enablers for the “Power-by-the-Hour” service (Ehret and Wirtz 2017). Sensors provide information that Rolls-Royce transmits in real-time to its ground-control centers. Here, Rolls-Royce gathers intelligence, with the potential for early warning of material wear, and indicate maintenance and repair needs. Passengers benefit from enhanced safety, airlines by a more efficient capital use and Rolls Royce enjoys the option on privileged profit opportunities. Not least, the physical network works as the barrier to entry for potential competitors. While there exists a differentiated market for airplane manufacturing services, including airline-owned maintenance and third-party providers, competitors would need to

invest into control centers, sensor-equipment, and world-wide communication connections in order to match performance levels offered by Rolls Royce (Smith 2013). Once in place, competitors would need to learn how to generate intelligence and activate it for service operations. While Rolls Royce has been investing in such systems since its pioneering investments in the 1970s (Smith 2013), it has reached a level of critical mass for capitalizing its services into financial liquidity, that is hard to match by fresh starters. Critical mass acts as an important barrier to entry as competitors would need a global presence to deliver their service at all major airports around the world. Most low-cost competitors simply do not have the volume to allow for a global presence effectively excluding them from this type of business model.

To conclude, physical network capital and critical mass provide the backbone for driving up scale and reaching critical mass for the liquidity for capitalizing investments in services. Companies with a dominant installed base of physical network capital can use it to develop a sustainable competitive advantage.

### *35.6.2 Platform-Based Intangible Capital: Critical Mass, IP and Platform Software*

Intangible capital like software, data-bases or methods for data analysis and intelligence is critical for unlocking value from physical information equipment (Chesbrough 2011; Wirtz 2016). Furthermore, physical information networks produce a growing stream of information on economic activities as not only people but a growing range of devices for transportation, manufacturing or household management gets equipped with sensors and actuators and is connected to the Internet (Ehret and Wirtz 2017). However, this exploding stream of data remains worthless without further analytical tools that generate intelligence and foster novel services. Google provided a pioneering example by developing algorithms that offer pathways for internet advertisers to find matches with valuable information searchers (Schmidt et al. 2014; Varian 2008). In those pioneering days, information tended to be valueless without appropriate algorithms and analytical tools that foster intelligence. The exponential growth of data has reversed the process: As several algorithms now contain self-optimizing and learning capabilities, algorithms are in need of an exponentially accelerating stream of data. Such artificial intelligence provides the backbone for a growing range of service innovations (Glushko and Nomorosa 2013), like autonomous driving, automatic translation, real-time energy management, or predictive maintenance.

Such algorithms are a key backbone of the intellectual capital embodied in the platform (Azevedo and Glen Weyl 2016; Brynjolfsson and MacAfee 2014; Ketter et al. 2016). IBM's Watson program provides a striking example how intellectual platform capital becomes the hub for a boon of service innovations, such as health, smart cities, or smart manufacturing (Hempel 2013).

Artificial intelligence provides also the intellectual backbone of an emerging new family of industrial services and solutions where platform providers connect real-time operations data with context information for managing, learning, and improving services and solutions. For example, General Electric is using artificial intelligence for smarter management of its power plants by using data on weather, traffic and user patterns for power and network management (Ehret and Wirtz 2017).

### 35.6.3 Platform-Based Social Capital: Network of Suppliers, Complementors and Partners

The social capital of a firm consists of the network of social relationships of a firm (Granovetter 2005; Florin et al. 2003; Xiong and Bharadwaj 2011). The extension of physical communication networks has stimulated dramatic shifts in the social capital of organizations, as online social networks cut across both, internal and external organizational boundaries (Huysman and Wulf 2004).

Building on the ubiquitous access opened by physical networks like the internet, intangible capital provides both, the potential to increase scale for a service for capitalizing service investments, as well as the establishment of service innovations building on new types of relationships. By connecting to platforms, asset-owners push their outreach, not unlike manufacturers using distribution channels in industrial economies. Sharing platforms like AirBnB, Uber or Wingly increase the relevant market for both, owners and potential users of facilities or equipment like flats, cars or jets (Chesbrough 2011).

While customer relationships are an essential element of social capital, platforms foster the emergence of novel relationships most notably between owners of facilities such as accommodations, cars or machines, service users, and other complementors such as programmers, or financial service providers that complement towards the service experience of users (Florin et al. 2003; Granovetter 2005; Ndubisi et al. 2016; Xiong and Bharadwaj 2011). In the context of networked economies, social capital is crucial for mobilizing resources and services beyond the boundaries of the firm, as well as provide the absorptive capacity that enables the firm to capture value (Florin et al. 2003; Xiong and Bharadwaj 2011).

Two- or multi-sided business models are the key where platform providers aim to attract a critical mass of demand for the capitalization of asset-based services (Landsman and Stremersch 2011; Wirtz 2016). Media-businesses developed the blueprint, where media audiences attracted by content provided the critical mass for sponsoring by advertisers. Google translated such models by offering internet-search for free and reach the critical mass for capitalizing search sponsorships (Schmidt et al. 2014; Wirtz 2016). Platforms work as critical backbones for developing new markets. Consider Etsy, which originally worked as an online sales channels for hobbyist and micro-entrepreneurs for commercializing self-designed accessories. Etsy's management soon had to learn that the restriction of single items

offered by designers puts a barrier on growth. By connecting designers to contract manufacturers, Etsy opened new channels for small batches of attractive designs that offered growth opportunities (Ehret and Wirtz 2017).

To conclude, social capital offers firms the lever for scaling up relevant markets, reaching critical mass for capitalizing investments, therefore, driving liquidity. Owners of platforms endowed with high social capital control a strong lever for sustaining competitive advantage.

## 35.7 Market-Based Assets

Market based assets empower a firm to explore and exploit opportunities related to customer needs. In market economies, value-in-use is the ultimate yardstick for economic activity where resources need to prove their worth (Macdonald et al. 2016; Menger 1981; Vargo and Lusch 2004). Market-based assets connect businesses to customers and enable businesses to explore customer needs, design service offerings and specify service contracts for effective service delivery. Essential market-based assets are the physical capital constituting the points-of-customer interaction, intellectual capital underlying brands and trademarks, and social capital constituting customer equity. We discuss these in turn.

### *35.7.1 Market-Based Tangible Capital: Points of Customer Interaction*

Service demand emerges through interaction between customers and providers, revealing customer needs, specifying requirements and creating orders (Grönroos 2012; Vargo and Lusch 2004). The history of the retailing industry provides an intriguing case. Retailers emerged as the Trojan horse that nested services in the context of goods-dominant industries. Retailers established themselves by taking a crucial role for manufacturers, extending market reach, increasing economies of scale and thereby competitiveness of manufacturers. With the maturing of the manufacturing base, retailers have been gaining a pole position at the front-end of value chains, getting insights into customer behavior and substantial clout for affecting the fortunes of manufacturer brands (Frazier and Summers 1984; Hunt 2015; Lusch 1976). Powerful retailers like Walmart have been pushing leading consumer brand manufacturers like Procter & Gamble to place heavy investments into innovations in order to stave off commoditization of their brands and regain attractiveness (Huston and Sakkab 2006).

At the high-end of the market, manufacturers try to regain strength by maintaining their own exclusive retail channels, allowing them to get direct customer contact and shape customer experiences and learning. For example, Burberry used a

retailing strategy by investing in a global retailing network as a key element in the recent relaunch of its fashion brand built around its classic trench coat (Ahrendts 2013). A growing range of high-end and luxury manufacturers like Tesla in electric cars (Hull 2015), Apple in computer electronics or Nike in sports fashion and Luis Vuitton in fashion, is investing in its own retailing facilities in order to shape the experience and gate the customer. There is a lot of value in being able to control the POS (i.e., what is presented to potential customers) and the customer interaction ("I can recommend. . .").

To conclude, owning points of customer interaction and access constitute powerful assets opening pathways to customers, exploring customer needs and generate demand that strengthens the power of their owners within the service value chain.

### *35.7.2 Market-Based Intangible Capital: Virtual POS, Communications Channels, and Brands, Trademarks and Loyalty Programs*

In a service economy, points of customer interaction have become increasingly virtual (e.g., websites and apps) and constitute the front ends of the service value chain, sensing customer needs, identifying potential service offerings, specifying potential third-party orders and not least, handling transactions including upselling and cross-selling, and financial payments (Agrawal and Schmidt 2003; Evans et al. 1999). Virtual POS command the same power in value chains as do physical ones and are the battleground in many industries (e.g., Amazon, Uber, and AirBnB's dominance in their industries are all based on virtual POSs and communications channels).

In addition to channels, brands and trademarks can be powerful market-based assets. Prior to the purchase, value propositions exist as mere promises of companies or expectations of customers. This puts brands on the center-stage of service businesses. Brands signal their capabilities and benefits, and show commitment and accountability (Chang and Liu 2009).

We find striking evidence in many industries like hotels (O'Neill and Matilla 2006), retailing, or integrated health systems (Zismer 2013) where brand owners govern the front-end of the service value chain, shaping expectations and perception of clients, while outsourced specialized service providers manage facilities, property, and capabilities for service delivery. Brands and their related brand equity build customer equity and work as the levers for conveying quality into financial value and therefore are a pillar for the pole position in the service value chain (Aaker and Jacobson 1994; Rao et al. 2004). Once a provider has succeeded to establish a brand, it is hard to copy (Bronnenberg et al. 2009, DuWors Jr. and Haines Jr. 1990: Yeoman et al. 2005).

Not least, in complex services like system-technologies or knowledge-intensive services, brands hold providers accountable (Aaker and Jacobson 2001). With their

brand image, brand owners offer their clients a self-enforcing mechanism, as opportunistic or unethical actions of providers jeopardize brand equity. Positive brand image shields providers of complex services against technically competent competitors who will need to build up brand equity to enter the evoked set of potential clients (Corkindale and Belder 2009).

To conclude, brand equity orchestrates client expectations with providers' brand personality and is the key to creating the trust basis enabling service transactions and mutual co-creation. By building brands providers create a unique, sustainable competitive advantage that is hard to copy and constitutes the pole position at the value chain.

### *35.7.3 Market-Based Social Capital: Customer Equity, Trust, and Goodwill*

Customer equity is a strong source of competitive advantage. Customer equity builds on customer relationships which constitute the market dimension of the social capital of a firm. Customer equity is a powerful asset connecting its owners to their customers, frequently providing a stable cash flow from a firm's customer base, effectively delivering services through customer co-creation and providing privileged insights into customer needs. Financially, customer revenues constitute the top-line of the income statement. Customer relationship management researchers reflect this when they define customer equity as "the total of the discounted lifetime values of all of its customers" (Rust et al. 2000, see also Kumar and Reinartz 2016).

Customers are also indispensable in the value creation process as they co-create value with the firm and their perception ultimately determine the value of product (Kumar and Reinartz 2016; Macdonald et al. 2016). Furthermore, besides actual transactions, customers offer value for the firm through their engagement (Rust et al. 2000; Kumar and Reinartz 2016). They affect the firm's fortunes through word-of-mouth, work as ambassadors for the firm through referral programs and referrals on social networks and in brand communities (Leone et al. 2006; Rego et al. 2009; Raithel et al. 2016; Wirtz et al. 2013) and hold valuable knowledge through their user experience of the firm's offerings.

Over time, customers can be a source of innovation and future products. Products can be copied and re-engineered by competitors and thereby will commoditize offerings and drive down profits. Well-established customer relationships provide knowledge and insights into user contexts and future needs, offering companies with opportunities to learn customer requirements as a lever for differentiating future offerings (Haenlein et al. 2006; Rust et al. 2000).

In short, relationships emerge through recurring interactions, driven by satisfaction, service quality and trust in competencies and good-will of providers (Morgan and Hunt 1994; Ndubisi et al. 2016). While customer equity is crucial for converting resources into financial performance, it is hard to build and copy—driving the asset-character of customer equity.

## 35.8 Employing Assets for Capturing Value Through Superior Organizational Capabilities

While this article focuses on which assets a firm should assume ownership in to allow capturing value, this discussion would be incomplete without considering the glue, the organizational capabilities, that hold them together and effectively deploy the assets discussed so far. Specifically, we identified four important organizational capabilities of asset integration that are independent of asset ownership but effectively link owned and outsources assets, capabilities, and processes to value creation and we proffer that these can also allow a firm to capture value. They are (1) a coherent business model itself that designs the architecture and "Gestalt" of value creation; (2) a customer-centric culture and a climate for service; (3) sustained innovation capabilities, and (4) the effective management of a tightly integrated web of processes and activities.

### *35.8.1 Business Models: Shaping the "Gestalt" of Asset Configurations*

Business models build a unique constellation of assets that together are hard to copy (Porter 1980). Business models build on key elements of which four are of particular relevance for services: (1) Establishing connections between resource and service markets; (2) identifying value propositions for individual firms; (3) identifying a value appropriation mechanism; and (4) identifying a network of collaborating firms or stakeholders for complementing the firm's value proposition into a compelling solution (Chesbrough 2011; Ehret et al. 2013; Osterwalder and Pigneur 2005; Wirtz 2016; Zott and Amit 2008). Here, business models provide the basis for designing an architecture of service assets and identify the "Gestalt" of their configuration.

### *35.8.2 Customer-Centric Organizational Culture and Climate for Service*

While assets do not drive agency, people do. Because both, clients and providers co-create services, providers need to develop processes for the effective interaction of the service partners. People and their embedding in organizational cultures, as well as service processes, are key conditions for transforming assets into value as well as differentiate the service firm and navigate it towards competitive advantage. Employees offer the key to service excellence to the extent that they develop a shared sense of service quality, not least the policies, practices and procedures and their impact on service quality (Bowen and Schneider 2014). By creating a favorable "service climate" firms shape their unique competitive position (Bowen and

Schneider 2014). Service climate builds on shared perceptions, values, norms, and working styles (Bowen and Schneider 2014).
Employees and service climate can shape in a unique and idiosyncratic way how the service organization differentiates its assets and resources. For example, Amazon, Vanguard and Singapore Airlines developed a competitive advantage due to the superior integration of the conflicting goals of service excellence and cost-effectiveness (Wirtz and Zeithaml 2018).

### *35.8.3 Serial Innovation*

In hypercompetitive industries, an organizational capability of innovating faster and better (even when these innovations are copied quickly by competition), can become a competitive advantage. Some organizations can be an innovation leader in their industry over prolonged periods of time (i.e. are serial innovators; Hamel 2006). Here, sustained innovation is a firm's capability to generate a stream of industry-leading innovations (i.e. multiple new products and services, encompassing both incremental and radical innovations). Innovation climate (i.e. leadership and innovative culture), human capital (i.e. recruitment, training and development and engagement and incentives), and resource configurations (i.e. structures, systems, and processes) were advanced as key foundations for success (Tuzovic et al. 2018).

### *35.8.4 Integrated Web of Processes and Activities*

The service process is the moment of truth for the contribution of any asset for its contribution towards value creation and capture. So far, we have mainly discussed the potential offered by assets. But left on their own premises, assets remain idle and will devaluate over time. Action drives value creation and firms can differentiate their assets through processes and activities. As Porter (1996) puts it: "*Competitors can quickly imitate management techniques, new technologies, input improvements, and superior ways of meeting customer needs.*" (p. 63). Rather, it is the "*fit, whereby the whole matters more than any individual part. Competitive advantage grows out of the entire system of activities*." (Porter 1996, p. 63). Services offer strong opportunities for creating unique webs and systems of processes and activities (Wirtz and Lovelock 2017).

First, as customer's perceptions drive service quality, service firms willingly or unwillingly differentiate themselves when performing with customers. Showing service effort and creating customer delight paths the way towards a unique image of the firm. Showing empathy and interacting with customers, empowers firms to differentiate themselves.

Second, services reside on multiple sets of activities, integrating resources and using technologies guided by people who show the potential for understanding and

interacting with customers. Thus, service organizations have a broad spectrum of choices for designing processes and orchestrate them towards unique service experiences. Such processes reside on organic eco-systems rather than vertical value chains. Singapore Airlines provides a telling example, as it links its service culture and climate for a continuous learning and adaption of processes and activities (Heracleous and Wirtz 2010).

## 35.9 Managerial Implications

Assets offer firms entry gates to profit opportunities but can turn easily into liabilities. Thus, on the path towards sustainable competitive advantage managers need to understand the relation of assets with opportunities. In our chapter, we identify three major domains as sources for opportunities which call for particular asset-types. Resource-based assets offer unique capabilities and capacity fostering service performance. Platform-based assets drive competitive advantage through service innovation, by enabling new connections between the resource base and service users. Platform-based assets provide the crucial means for driving scale, liquidity and critical mass for capitalizing investments into services. Market-based assets open pathways for companies to exploration and exploitation for unmet demand by potential service clients, namely through points of customer interaction, brand equity, customer equity.

### *35.9.1 The Case for Selective Ownership Approaches*

The key implication for management is the urge for selective approaches to asset-ownership. Management concepts like outsourcing or non-ownership have raised the awareness of alternatives to ownership as well as questioning the scope of ownership. Despite the rise of effective alternatives, ownership of strategic assets remains a key pillar for differentiation and capturing profits. Thus, managers should strive for selective ownership rather than simple non-ownership approaches. As a general rule, managers should identify, establish and nurture the key assets as sources of their competitive advantage, and complement these with external services offered by excelling third-party service providers. Key assets should be tied to market opportunities. Thus, managers need a dynamic approach towards asset ownership as the market environment can shift in favor of particular kinds of assets while commoditizing others. For example, technology developments can raise the attractiveness of ownership of assets. In the car industry, batteries used to be outsourced to component suppliers, while they have now reached the center stage of in-house development and even manufacturing. The rise of artificial or augmented intelligence has been strengthening the urge of Apple to grow its own processor, which it had outsourced for a substantial time.

### *35.9.2 Asset Configurations and the Case for Business Services*

Critical assets can be found on all stages along the value chain. Thus, managers should keep a clear mind and open view especially on assets that are positioned in seemingly distant areas in the value chain. Especially companies that have a reputation for strong outsourcing maintain a variety of critical assets along each step of the value chain in-house. For example, Nike might have a justified reputation for extreme outsourcing but owns critical assets on each stage of the value chain, including resource markets, for example, the design of critical materials and textiles, in addition to signature shops and internet-sales platforms besides investing in one of the most valuable sports and fashion brands.

In order to be valuable, assets need to be unique. Ownership is the main tool that empowers managers to establish and protect distinctive resource combinations. At the same time, resources need to be conversible, urging managers to establish and maintain interfaces downstream with customers and marketing channels. These conditions of uniqueness and conversibility of resources push companies to invest into configurations of assets where some assets provide unique sources of value while others might path ways towards customers.

In that regard, platforms offer a useful metaphor for the business model design of almost any business. As most businesses start from stronger positions either in the downstream product or upstream resource markets, strategic and attractive positions are intrinsically linked to both. Even when companies feel far off world-market dominating positions like Qualcomm, Google or Apple, they face similar challenges on smaller levels in different contexts: How can they provide unique value and maintain a strong bargaining position with their customers? Here competitive advantages build on strong positions in both up- and downstream markets.

## 35.10 Research Opportunities

In our chapter, we provide a starting point by identifying the roles of assets in the process of exploring and exploiting business opportunities. In the following section, we identify potentially interesting research opportunities.

### *35.10.1 Selective Asset Ownership*

The non-ownership perspective has provided a useful and theoretically well-founded criterion for the definition of services (Lovelock and Gummesson 2004). The rise of the service economy goes in hand with a growing range of business services that allow organizations to outsource an ever-increasing range of assets and activities

(Ehret and Wirtz 2010). In order to exploit the full potential of this approach, service research needs to look at the flip-side of non-ownership, that is, the role of asset ownership in the service economy. The hidden assumption underlying the viability of non-ownership service business models holds that there exists an actor who takes-on ownership of the assets that are used for service-delivery.

To some extent, non-ownership provides business opportunities to service providers who are willing and capable of taking on ownership deemed of little value by other participants in the value creation process. Thus, service research needs concepts that reflect the full implications following from selective ownership approaches. What conditions, capabilities and resources empower service providers to handle assets that fall out of the scope of their potential clients? Ownership offers crucial incentives for companies to focus on specific domains of value creation, mainly by vesting power towards service providers and offering them profit opportunities. Still, the question remains, what factors render an asset valuable for one firm, while it seems to have become of little value to others.

Property-rights theory offers a valid starting point for understanding such phenomena in static positions by looking at the transaction cost implications of asset specificity, rendering ownership valuable for companies with comparable higher opportunity costs, while favoring service-sourcing with lower opportunity costs (Barzel 1997; Ehret and Wirtz 2010; Grossman and Hart 1986). As we show in our discussion, such perspectives are snapshots of dynamic processes. In the face of increasing competitive pressure, both researchers as well as managers, need an understanding of dynamic factors that prior to the specificity and opportunity costs of assets beyond the transaction cost implications. This is the background of the growing efforts in entrepreneurship research as well as in business model design (Chesbrough 2011; Zott and Amit 2008).

### *35.10.2 Asset Configuration*

Conceptual reflections regarding asset ownership reveal a greenfield of research opportunities for service research. Extant empirical research has remained almost blind on the role of assets in service provision. We need a better understanding of the asset configurations owned by organizations. For example, the combination of intangible assets like brands and platforms with tangible assets like technological equipment and real estate. Such typologies of configurations would mark the first step in systemizing our understanding of antecedents that motivate companies and their stakeholders that drive the emergence of such ownership structures. Ultimately, we need a better understanding of how particular asset configurations affect the performance of firms, the quality of their services, as well as their economic and social value on a macro-level.

### *35.10.3 Real-Option Value of Nonownership*

Nonownership decisions build on the asymmetric perception of uncertainties. Nonownership service providers embrace uncertainties that their clients loaf and are willing to pay service fees for discarding them. Arguably, asymmetric uncertainty is a key condition and source of nonownership value, if not service value in general. From a financial perspective, service contracts share some features with financial options. Service clients enjoy the right to benefits of a service without the obligation to bear the downsides. Thus, service clients enjoy benefits quite comparable to those of option holders who hold the right, but not the obligation, to sell a stock at a certain price at a certain time. Like option holders only risk the option price, service clients limit the financial risk to the service fee (McGrath et al. 2004).

Service research has not yet reflected the potential offered by real-options for the systematic valuation of non-ownership services and services in general. While research still faces methodological challenges in real-option valuation, researchers are making progress and can look forward to a growing stream of data on financial valuation and the environment of services (Taleb 2012).

### *35.10.4 Core Competencies, Service Culture and Asset Creation*

We have stressed the managerial challenge in matching assets and with a firm's capabilities and culture. However, we have scant evidence that competencies and the culture of a firm shape the types of assets employees develop and managers seek to control. Companies cultivating innovative cultures tend to develop higher shares of intellectual assets. We have reasons to assume that assets hold the potential to work as a strategic repository for values, knowledge, and competencies cultivated within a firm. These open up opportunities for research to explore systematic trajectories between corporate cultures and the acquisition, creation, and management of strategic assets within a firm.

## 35.11 Conclusions

In advanced service economies, almost any activity, skill, and asset can be bought on competitive markets, making it increasingly difficult to build competitive advantage on any of those inputs. This emergence of service B2B business models reflects the pressure of hyper-competition forcing companies to focus ownership on those assets that offer them the highest potential for value appropriation while delegating ownership of non-essential assets to service providers. Therefore, firms have to carefully decide what to own in order to capture value. That is, firms have to explore what

types of assets can add value to their customers and at the same time are difficult or illegal to copy by competition. We identified key asset categories that potentially allow a firm to appropriate value and argue that each can take the form of tangible, intangible and social capital. The three asset types and their three manifestations are integrated into a framework for an asset typology (see Fig. 35.2). In addition, we proffer four organizational capabilities of asset integration that potentially also can form the base for an organization's competitive advantage. We hope that this conceptual chapter will lead to further investigation into the intriguing question of the role of asset ownership in capturing value in modern, highly specialized service economies.

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# Chapter 36
# Service as Intersubjective Struggle

**Yutaka Yamauchi**

**Abstract** As long as service is characterized as value co-creation achieved jointly by multiple participants, service lies between the participants rather than reduced to any single one. This intersubjective nature of service forces us to break with subject-object dualism. That is to say, the customer and the service provider—subject—cannot judge the value of the service—object—from a distance. The customer as well as the provider is implicated in the service. When the value of service is concerned, the value of the participants, who are inseparable from the service, is also at issue. Specifically, they need to present who they are. An ethnomethodological study of videotaped customer-provider interactions at traditional sushi bars in Tokyo reveals that while engaging in service interactions, customers present how familiar and qualified they are in relation to the service and providers present how special their service is. By bringing this intersubjectivity to the fore, this chapter proposes a new theoretical perspective portraying service as dialectical struggle in which involved parties seek to demonstrate their own selves in relation to others. This perspective helps move beyond the notion of subjective customer satisfaction and explain some counterintuitive facts of services such as service providers who do not appear to care about customers' satisfaction.

**Keywords** Value co-creation · Intersubjectivity · Service interactions · Dialectic · Ethnomethodology

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P. P. Maglio et al. (eds.), *Handbook of Service Science, Volume II*, Service Science: Research and Innovations in the Service Economy,
https://doi.org/10.1007/978-3-319-98512-1_36

## 36.1 Introduction

The study reported in this chapter begins with a puzzle: Service at sushi bars in Tokyo appears to be organized differently from that reported in prior service research. Sushi chefs, who prepare and serve sushi facing customers, rarely smile, a situation that does not put customers unfamiliar to these settings at ease. Written menus are not provided and prices are not revealed. Customers do not know the price of a meal until they receive the check. Above all, sushi chefs do not try to please customers. As a result, many customers, not only foreign tourists but also those raised in Japan, are intimidated by overall atmosphere of this service. Yet, these patrons are still willing to pay a significant amount of money for this experience. How can services that do not seek to ingratiate patrons attract so many customers and prosper?

Service science (Maglio and Spohrer 2008; Spohrer et al. 2007) and specifically its foundational service-dominant (S-D) logic (Vargo and Lusch 2004, 2008, 2016) provide a framework for beginning to understand how and why this kind of service is possible. That is to say, the idea that value is co-created through interactions among customers, providers, and other actors, including both direct and indirect interactions, is an important step in illustrating this type of exchange. As no single player can unilaterally create value, we need to examine interactions between the various individuals involved. S-D logic in general has enabled us to examine interactions in which actors integrate resources through institutionalized processes; in particular, some scholars have advanced the interactional aspects of this process (Ballantyne and Varey 2006; Fyrberg and Jüriado 2009).

Yet, even within the S-D logic literature, there is no readily available theoretical explanation providing answers to the above puzzle, and there is even less relevant evidence in the larger body of service literature. Therefore, we need to take key ideas from S-D logic and synthesize a new theoretical perspective. To provide a basis for this theoretical development, we delve into actual service interactions through which value is co-created. Specifically, this study conducts empirical research by videotaping and analyzing customer interactions at four upscale sushi bars in Tokyo.

The current study elaborates the concept of intersubjectivity (Edvardsson et al. 2010; Helkkula et al. 2012; Löbler 2011; Peters et al. 2014), which here refers to interactionally achieved social order. That is, rather than reducing social order into what people subjectively hold in their minds, we analyze how actors present their own understanding of a situation to each other in their observable actions. We draw on ethnomethodology (Garfinkel 1967) in elaborating this intersubjectivity. Obviously humans do not have the power to read others' minds, yet participants in these interactions can still achieve service as an ordered phenomenon. This means that participants have their own methods to achieve this order without external analysts to determine what others subjectively have in mind. This last point is vital, as the subjective information is not accessible to others and thus cannot be the basis for social order. Furthermore, in this intersubjective framework, actors cannot detach

themselves from the service and subjectively judge its value; they are implicated in the service itself and, by taking actions observable to others, need to present their own selves in this context. The goal of this chapter is to outline this new theoretical perspective and advance our understanding of service within S-D logic.

## 36.2 Service as Intersubjectivity

### *36.2.1 Value Co-creation in Service*

With an emphasis on value co-creation and resource integration through direct and indirect interactions, S-D logic allows us to examine the puzzle of service interactions. From a S-D logic perspective, actors collaborate and co-create value (Lusch and Vargo 2014). Even though value is considered to be uniquely and phenomenologically determined by each participant, stakeholders co-create the context that frames the phenomenological experience (Akaka and Vargo 2015; Chandler and Vargo 2011; Helkkula 2011; Löbler 2011). A business cannot dictate value; it can only propose the value. Service requires active participation from all involved parties, including customers. Value is co-created through joint activity, and therefore the value cannot be reduced to any one of the actors or to the objective conditions.

Several scholars have discussed the centrality of interaction and therefore the intersubjective nature of service. In contrasting dialogue with communication, Ballantyne and Varey (2006) wrote:

> It follows that dialogue cannot be reduced to one person's activity alone, or reduced to one person's perspective alone – it is inherently relational. Engaging in dialogical interaction is not unidirectional, self-serving, or accomplishment by control. On the contrary, the purpose is open-ended, discovery oriented, and value creating. (p. 339).

We bring this interactional and relational conception of service to the fore. Value co-creation is then in the "inter" between actors rather than in each individual. Edvardsson et al. (2010) made this clear in their first proposition: "Value has a collective and intersubjective dimension and should be understood as value-in-social-context" (p. 333). Similarly, Acknowledging both the subjective and intersubjective aspects of value, Helkkula et al. (2012) similarly stated in their first proposition: "Value in the experience is individually intrasubjective and socially intersubjective" (p. 3).

In line with this debate, Löbler (2011) clarified that S-D logic is characterized primarily as intersubjective orientation: "Proposition 1: Service-dominant logic is laid out as an intersubjective undertaking" (p. 67). Although some parts of S-D logic appear to fall under subjectivism, it is essentially an effort to overcome the subjectivist orientation that focuses "on the subjects investigating the object" (p. 56); therefore, "service is interactive and hence intersubjective" (Löbler 2011, p. 62). This intersubjective orientation of S-D logic should be more thoroughly extended, as Peñaloza and Venkatesh (2006, p. 306) claim, if we "move explicitly from a subject–

object relation between marketers and consumers towards a more subject–subject relation."

As Husserl (1950) formulated from the standpoint of phenomenology, intersubjectivity refers to what happens between people; this is in contrast to subjectivity, which is what each person has in mind. The fundamental difference exists between the social reality that is achieved between people and the subjective perception and construction of the world in each person's mind. If we begin with what people subjectively perceive and transcendentally construct, as Husserl did, it is difficult, if not impossible, to explain how what one person sees is the same as what is seen by another, and thereby how the objective world can be constructed. In everyday situations, a person obviously does not analogically infer that what others see from their standpoint must be the same as what s/he sees at the moment; transcendental constitution must take place at a more fundamental, a priori level (e.g., Merleau-Ponty 2002).

It is, however, difficult to explain how social order is achieved in reality if we group all explanations into a priori transcendental structures; this is particularly true for social scientists who must explain actual social phenomena. As a result, some theorists have moved beyond the subjectivist framework and sought to base their work in the intersubjective realm. That is, we should not begin with considering what people see, think, or feel internally but focus on the communication or interaction among people. Here we can review only two major scholars who have developed relevant frameworks. Luhmann (2013) famously placed individual subjectivity not in the social system but in its external environment. He explained that the social system as a series of communications is closed and has its own self-organizing principles; individual subjectivity as psychic systems are coupled with this social system, but only in an indirect manner. While Luhmann goes even further to eschew subjectivity altogether, the point that the social analysis should not base itself on subjectivity is an important step. Similarly, Habermas (1987) criticized the philosophy of consciousness, which begins with subjectivity, and advocated intersubjective communicative actions. He aimed to construct a philosophical system based on this intersubjectivity.

In the context of this chapter, we specifically build on ethnomethodology (Garfinkel 1967). While the term intersubjectivity is not typically used in ethnomethodology, this designation helps connect the basic idea of ethnomethodology to S-D logic. Intersubjectivity here refers to the social process in which individuals display their respective understandings to each other and achieve alignment regarding what is occurring in a particular situation. What one individual subjectively thinks is irrelevant because others in the situation have no magical access to this person's thoughts; each individual needs to display his or her understanding and others in turn display their understandings of this original action. All actions are undertaken intersubjectively in that each person makes every action observable, understandable, and describable by others. Ethnomethodology clarifies this through the notion of accountability (Garfinkel 1967). When we take an action, we do not do so at a random time or location. We choose to do so in a particular situation to render the action observable, understandable, and therefore accountable; that is, others in

the situation can account for it. For instance, a service employee in a restaurant solicits a drink order in a particular way. He cannot ask this question when a customer has a full glass: in this case, "Would you like anything more to drink?" would sound like a complaint that the customer is not drinking enough or is drinking too slowly. Note that we do not need to clarify what the service employee had in mind subjectively; the action has an accountable meaning for those in the situation precisely because of what the action does in the particular context. People do not take actions blindly; rather they make their actions accountable by utilizing and constructing context. Ethnomethodology can empirically analyze how this is achieved.

In intersubjective understandings achieved among individuals, it is not assumed individuals have the same understanding because each one cannot know what others have in mind. There is always a possibility that people misunderstand each other. Yet, we can and do live with this reality. We seek to understand what others are thinking but ultimately we conduct our lives without a complete understanding of the others around us, and we are often surprised to see that misunderstandings can go unnoticed for quite some time.

### *36.2.2 Subject–Object Entanglement*

Furthermore, this view of intersubjectivity means that we can no longer assume subject-object dichotomy. If the service context is co-created, then a person, a "subject" if we use this concept for the time being, cannot keep a safe distance from the service, the "object"; this person is involved in the service (Sampson 2010). Let us assume that a customer is evaluating the value of a restaurant service. Yet, this service is a joint achievement in which the customer is also implicated. Therefore, she is in fact evaluating not only the service but also herself, who is part of the service. That is to say, the value of service encompasses the value of the involved parties. Specifically, a customer's value is centered on the issue of who the customer is. In upscale French restaurants, customers may feel anxious picking wine from a lengthy list; there is a concern as to how much knowledge and experience this customer has and whether she is qualified for the service. This is precisely because she is part of the service and her value, who she is, matters. As Peñaloza and Venkatesh (2006) wrote, service processes "always *implicate the one in comprehending the other*" (emphasis in original).

Therefore, the value of the service cannot be separated from the value of the individuals themselves. When individuals enter a service context that they co-create, these persons inevitably present themselves to each other just as presentation of self is inherent part of social gathering (Goffman 1959). Individuals present themselves as qualified customers having certain tastes, and service providers present themselves as professionals with sophisticated and distinguished skills. Here, already people are dealing with value; they are showing what value they can claim for

themselves. This value is intersubjectively presented and negotiated rather than subjectively determined.

There is certainly an emphasis on value in the realm of subjectivity. For instance, there is value of a fine wine at a restaurant. When customers judge the wine, this is a value that they can subjectively judge as the individuals are not immediately related to object of value. Nonetheless, there also exists an intersubjective value; if a customer says, "This wine is delicious," when tasting a rare wine, this remark affects the person who made it. Here, the customer is defining himself as somebody not sophisticated enough to use more nuanced language when tasting a fine wine. The customer is implicated in the value. Therefore, the point is not to deny the subjective value of an object, e.g., the perceived quality of wine, but to highlight the intersubjective value that is an inevitable part of service. If we focus only on the subjective value, then we need not talk about co-creation; we simply remain in goods-dominant logic.

### *36.2.3 Intersubjective Struggle*

One model to explain this intersubjectivity is dialectical struggle for recognition (Fraser and Honneth 2003; Honneth 1995, 2008). This model is useful precisely because of the dialectical nature of service: When a service provider tries to satisfy a customer, the customer will not be satisfied in an expected way. This relationship can be explained following Hegelian lord-bondsman (master-slave) dialectic (Hegel 1977).

The Hegelian lord-bondsman dialectic posits that, to the extent that we are self-consciousness, we are both the one that is conscious of something else and the one that our consciousness is conscious of; we have ourselves as both subject and object. As such, we are interested in how we are viewed as well as how we view things. Therefore, we are all seeking recognition from others. To seek recognition, we must prove ourselves and demonstrate our abilities. Yet, when we try to impress others, we inevitably negate these others as we exceed their expectations. We show that we are better than they think we are. As a result, we demonstrate that we are better than others, i.e., negating others, and others also try to negate us. This mutual negation leads to what Hegel sees as a life-and-death struggle.

Here, one member of this struggle comes to prove that she can be certain of herself without reliance on others; she becomes a master. The other comes to rely on this master in order to define himself; he becomes a slave. The master can now gain the recognition that she has sought; that is to say, the slave gives her absolute recognition. Nonetheless, this recognition does not work as expected because recognition from somebody dependent is no longer of value. That is, the recognition no longer acts as recognition because it is not from an independent person capable of judging whether she is worthy of his recognition. The dominant relationship in which he is subdued therefore leads to a lack of value in his recognition. This is the master-slave dialectic: When we obtain the recognition we seek, we lose it.

When a service provider tries to satisfy a customer, the service provider becomes dependent on the customer to the extent that the customer's choices and actions can have a significant influence on the service provider. Then, the service this customer receives from a dependent individual is perceived of lesser value. This phenomenon directly illustrates the intersubjective nature of action; we do not simply create reality in our own heads. One's actions are always in relation to other individuals and therefore involve the issue of who one is vis-à-vis these other individuals. The action of satisfying a customer inevitably alters the relationships between the service provider and the customer and therefore alters who the service provider is and who the customer is. Because service is intersubjective, this dialectic struggle is a fundamental property of service.

In the same way, when service providers try to show value of their service, they do so only in relation to their customers. Presenting a service as valuable, service providers show that the service is superior vis-à-vis the customers. This involves negation of the customers. That is to say, service providers define their services to be better than what the customers experience in their everyday life. In upscale French restaurants, customers are often given menus and wine lists that are very esoteric. Difficulty may arise from an absence of descriptions or ones that they are filled with unfamiliar language; these are signals showing the offerings at the restaurant exceed what customers can easily comprehend. That is, if the restaurant only provides what customers find familiar, there will likely not be special value in the experience.

### *36.2.4 Intersubjective Cultural Representations*

Although the above discussion focuses on dyadic relations between a service provider and a customer, intersubjectivity is not confined to these two parties. Scholars have criticized such a narrow view as the extension of goods-dominant logic (Vargo and Lusch 2016; Vargo et al. 2010). In service dominant logic, a clear distinction between the service provider and the customer is suspect. All parties contribute and integrate resources to realize benefit for the others.

The intersubjective struggle outlined above belongs to the realm of culture; it is not part of the individual characteristics or a specific social relationship between the two parties. When individuals engage in this type of intersubjective struggle, they are in effect attempting to define and negotiate a specific cultural encounter. A service provider tries to define certain culture that customers would value highly. Customers on the other hand try to influence the culture and define themselves in relation to it. The culture is part of the consumers' as well as other actors' operant resources (Arnould et al. 2006). Individuals apply a variety of cultural resources, such as cultural schemas and categories, and embodied tastes to this process. Moreover they also bring specialized language and 'lifeworld projects' to an interaction (Arnould et al. 2006).

Here, culture is not considered to exist as a universal norm. Culture is always a relational concept (Clifford and Marcus 1986). We do not think of American culture

when eating a hamburger or Japanese culture when using chopsticks; we simply engage in these actions and take them for granted. The notion of culture emerges only when we come into contact with others who have a different set of orientations. Therefore, culture is constructed from social relation with others. To this extent, then, culture concerns defining oneself in relation to others, which in turn involves defining others in relation to oneself (Cayla and Arnould 2008; Said 1978).

This aspect of culture can be easily seen in the example of an upscale French restaurant that defines itself as sophisticated, a self-definition that is always in relation to others, e.g., customers and competitors. For instance, a restaurant's definition of its customers and the way customers define themselves are both parts of this self-definition because the restaurant is suggesting that in relation to the customer the restaurant represents a sophisticated culture. That is to say, these customers should find the experience non-quotidian and special, different from their everyday existence. It follows that these customers would feel a need to live up to that sophistication. In other words, an upscale French restaurant is not simply cultural because of its geographical origins; it is consistently and actively presenting a certain culture to the customers.

## 36.3 An Illustration: Sushi Bars

To empirically demonstrate how this type of intersubjectivity works, sushi bars in Tokyo can be illustrative. As shown in the very beginning of this chapter, this research began with a puzzle: sushi chefs behaved in ways that could not be explained easily by prior theories of service. These chefs made the service difficult and intimidating for customers. The theoretical perspective reported in this chapter, namely intersubjectivity, was developed in order to explain this phenomenon.

Although sushi bars comprise a broad range of businesses, the discussion here focuses on the top tier sushi bars in Tokyo, i.e., the most expensive category. It is this top tier of sushi bars that epitomize the sushi culture that Japanese citizens would think of when hearing the word "sushi." These sushi bars are quite expensive, ranging from USD150 to 400, including drinks, per person. This chapter also focuses on the Tokyo style sushi bars, which is the most typical style of sushi in Japan. This is called Tokyo-style (*Edomae*) sushi.

Before the description of interactions at sushi bars, a summary description of sushi service will be provided, particularly its specific culture.

### *36.3.1 Sushi Culture*

Although sushi is now a global cuisine, sushi in Japan has a unique culture. For the Japanese, sushi means not only the sensory pleasure of the food itself, but it also carries the connotations of a unique experience. Sushi bars are considered to be

intimidating. Master chefs are often inhospitable and conduct service without smiling or other outward signs of graciousness. Customers often feel anxious ordering sushi from these chefs; eating sushi in front of them is also quite intimidating. Perhaps the most salient characteristic of sushi bars is the fact that no prices are displayed for food and drinks. Customers are given the bill only after the meal. Moreover, most high-end sushi bars have no written menu. In a few, there is a list of available fish on the wall, but still here the information is minimal and price is not indicated.

Therefore, customers are expected to have certain background knowledge so they can properly order food and drinks without menu listings or prices. Customers should know what kind of fish is in season and also have some idea about price ranges. They can always ask for a chef's recommendation; however, some chefs refuse to give a recommendation. A typical joke is that chefs reply, "We don't serve anything that we don't recommend." This type of interaction places a great deal of burden on customers.

Similarly, traditional sushi bars have a system in which customers order one item of sushi at a time. This system is called "Okonomi" or "as you like." Customers choose whatever type of sushi they want. The proper order in which customers should choose sushi is the subject of interesting debate. There is a standard custom that one should begin with white meat fish because of the lighter taste and end with gourd rolls and sweet tasting sushi similar to desserts. People debate whether this should be seen as a rule; many reject this idea and suggest that customers should choose whatever they want in whatever order. Yet, Japanese customers are aware of this discourse when they frequent a sushi bar. Here, again customers are expected to know certain rules.

Many sushi bars have adopted a chef's choice system, known as "Omakase." Here, customers do not order each piece of fish themselves, rather they are given a selection by the chef. Even in this case, customers often supplement their meal with their own choices after the Omakase course has concluded. In this case, the choices are difficult because customers are expected to make correct choices among the sushi they have tasted as part of the course; for instance, picking selections that the chefs consider to be excellent is a sign of proper taste. They also need to order drinks individually, all without understanding of prices until the bill comes. Drinks are also the subject of debate; some say that people should not drink alcohol in sushi bars because traditionally people ate sushi with green tea and others say that sake, made of rice, conflicts with taste of the rice in sushi. Many other people believe sake pairs well with sushi. Still others suggest that white wine goes well with sushi. Therefore, choosing the right drink in this situation is not straightforward.

There are many other manners and rituals found at these establishments. It is considered the norm to eat sushi by hand, not with chopsticks, which is awkward for most Japanese who are not accustomed to this practice. Customers are expected to eat sushi as soon as they receive it from the chef. Leaving sushi on the plate is considered rude because the sushi is best when it is first prepared and can quickly dry out. Additionally, there are taboos regarding what people can talk about and what language is acceptable in these situations. Some customers desire to show off

extensive knowledge and experience. This is not advised; in fact, many people strongly object to this kind of behavior seeing it as vulgar.

### *36.3.2 Methodology*

The current chapter incorporates ethnomethodological research in which interactions were videotaped as they naturally happen and analyzed them in detail. The empirical material is taken from the author's research project, parts of which have been reported elsewhere (Yamauchi and Hiramoto 2016). This previous paper had a theoretical agenda different than that explored in this chapter. However, some of the same empirical materials are used here. Ethnomethodology is a sub-field of sociology initiated by Harold Garfinkel (1967) and subsequently developed by other researchers (Heritage 1984; Sacks 1995; Schegloff 2007); it seeks to explicate the methods people use to accomplish social order. Specifically, in terms of the current study, when two or more people meet to engage in some kind of social activity, such as placing an order in a service context, the goal is to explain how they can achieve that activity by presenting their understanding of each other's actions.

It is important to note that we can achieve a social activity without knowing what others actually have in mind; for example, we can place an order without the provider reading our thoughts. When we take an action specifying an order, we make sure that our action is accountable as an action of placing an order. Therefore, ethnomethodology is particularly useful in examining how service is achieved through interactions.

Multiple camcorders and a number of voice recorders were placed in four selected sushi establishments. All the audio and video data were synchronized. Then all interactions between providers and customers were transcribed. Acts of ordering appeared to be the most critical moments because a number of actions were required of the customers, whereas in receiving food the customers did not need to do much except for providing an acknowledgement (e.g., nodding). Intersubjectivity is particularly salient when some discrepancy exists between parties as opposed to situations where things smoothly unfold. For the same reason, the analysis of the initial part of the service is reported in this chapter. The initial interactions are critical because at this moment the customer has not familiarized him or herself with the service and the chef has not learned much about this customer. Analysis can continue and show similar patterns for subsequent interactions but is not reported here in full due to limitations of space.

### *36.3.3 Analysis of Initial Service Interactions at Sushi Bars*

The initial interactions unfold as following. First of all, the interaction begins with the provider's question asking for a drink order. Subsequently, we see three different

patterns in customer responses. Concretely the experience and knowledge of the customer become evident through the ways in which customers respond to the initial question.

In the following fragment, a customer gives an answer in a concise manner. Here AS indicates an assistant who assist delivering drinks. In most cases, chefs behind the counter are the first to address the customers a question but in this case, the assistant approaches and asks the question while the chef watches the interaction. B3 is a customer, "B" indicates the second of the four sushi bars studied. The numbers are uniquely assigned to customers. Brackets "[]" indicate that multiple spoken utterances overlap, i.e., they start at the same time. The number in parentheses "(0.2)" indicates the seconds of pause—0.2 s in this case. The dot "(.)" indicates a short pause less than 0.2 s. Colons ":" indicate prolongation of sound. Double parentheses "((something))" are the authors' addition or comments.

**Fragment 1**

```
01 AS  :  What would you like to dr[ink
02 B3  :                           [Beer please
03  (.)
04 AS  :  As for beer (.) ((We have)) large and small [bottles
05 B3  :                                              [We↑:ll
06 B3  :  All right then a small bottle.
07        (0.2)  ((AS nods))
```

The first question in line 01 is a standard one, which was consistently observed in all the four sushi bars. This question is asked after brief greeting and while the customer is seating himself. Some observations can be made. First, the customer indicates "beer" in a quite concise manner without any preface. Also note that he started answering while the assistant was still asking a question. These features suggest (to them as well as to researchers) that the customer had no difficulty in understanding the question and moreover expected to receive this very question at that moment. He required no time to think about his choice.

Although all these observations may sound trivial, we should understand that at this moment the customer was not given any information about what drinks were available in this sushi bar or, for that matter, no written menu. Beer would seem to be a safe choice because it is available in any restaurant and the price is assumed not to be exorbitant. This customer was patronizing the sushi bar for the first time, something of which both the assistant and chef were aware. However, the assistant did not even give the customer any time to settle into his seat.

Nonetheless, we cannot simply take this interpretation as a matter that shows generalizable facts. We need to explain how participants themselves exhibit this in their understanding. To do so, we can turn to cases where customers do not answer the question as concisely. The following fragment took place at the third sushi bar (C). Among multiple sushi chefs, Chf2 was involved with this customer, C3.

**Fragment 2**

```
01 Chf2 :  Drinks
02  (.)
03 C3   :  hhhh(0.3)The::n(.) Shall I get a glass of be[e::r
04 Chf2 :                                               [Uh:m
05  (.) we have medium and small bottles
06  (0.2)
07 C3   :  Then small bottle:: please.
08 Chf2 :  A small bott[le
09 C3   :              [Yes
```

Compared to the last fragment, certain features are noticeable. First, there is no overlap of utterances and instead a brief pause (line 02) after the question, which is also more concise, comprising only one phrase (in Japanese, “o-nomimono wa”). Second, there is a rather long preface to the answer. “.hhhhh” indicates an extended in-breath. Third, the answer is more elaborate with a complete sentence, compared to the concise answer in the previous fragment. Fourth, there is a prolonged sound at the end of the sentence “bee::r”. These aspects suggest that the customer was not ready to answer promptly and required some time to respond. The prolonged sound at the end was issued while he was briefly looking at the chef, indicating that he was seeking some feedback. In contrast to the previous fragment, this customer presents actions demonstrating the chef’s reaction is relevant to complete his talk. From this, we can see that this customer was uncertain as to how the chef would interpret his action.

We can elaborate this analysis with a similar case, in which the same pattern can be seen. This fragment is from the first sushi bar (A). Equal signs “=” indicate that two turns were connected without any gap (typically a brief pause is inserted between turns). Greater than and less than signs show the pace of utterance—“<slow>” is said slowly and “>fast<” is spoken rapidly.

**Fragment 3**

```
01 Chf  :  U:::m .hhh to begin (0.5) [What] would you like to
02  drink.=
03 A1a  :                             [Yes-]
04 A1a  :  =Mm::::(.)because it is <humid>: I'll have ddraft
05 beer:
06 Chf  :  >Let's go with draft b[eer<
07 A1a  :                         [Is dra[ft okay¿
08 Chf  :                                [>Yes it is<
((continues))
```

The customer’s answer in line 02 shows features similar to the answer in the previous example, specifically, the preface and the prolongation at the end. We also see that he stammered slightly when saying draft, producing “ddraft”. Here, we further observe that the customer provides a reason for his order, “because it is <humid>:” Why does he give a reason for his order? The answer does not lie in his

actual thoughts at that moment; rather it should be located in terms of how this action is presented. We can observe that both the customer and the chef can see that the reason was relevant at this moment for the customer. He was justifying his order or giving more information so that his order can be understood properly. In any event, this customer presented the uncertain nature of his order, which could not stand on its own.

Looking at how the chef responds in line 06 validates this analysis. This response beginning with "Let's" is a noticeably emphatic action. By using "Let's" the chef involves himself. Effectively he is signaling agreement to the customer's choice. Through this response, the chef presented his own understanding of the uncertainty the customer exhibited, and this affirmation from the chef would be relevant to the customer. In short, the second pattern shows that the customers present uncertainty of their actions in response to the chef's initial question although they could succeed in completing the utterance indicating an order.

As the third pattern shows, chefs know that some customers have trouble answering their questions. The parentheses without a number show that talk was not discernible.

**Fragment 4**

```
01 Chef :  What would you like to drink
02  (0.5)
03 A3a  :  We::ll uh::m (1.2) (........) [do you have
04 Chef :                                [Ah beer,
05 A3a  :  un:=
06 Chef :  =sake,
07 A3a  :  Yes.
08 Chef :  U:m shochu.
09  (0.4)
10 A3a  :  °hum°=
11 Chef :  =a glass of (0.3) white wine or, champagne
12          [or something
13 A3a  :  [huh:
14 A3a  :  .hh uh:m <for me> beer(0.3)for beer how many
15      kinds do you have
((continues))
```

When the customer's response is not forthcoming in line 03, the chef quickly started listing possible items to choose from, beginning with beer in line 04. When the customer was talking in line 03, he was looking right and left, visibly seeking information, e.g., what other customers are drinking and some other information within the space of the restaurant. In seeing this, the chef offered some hints. Then, the customer could choose one of the suggestions, beer. Therefore, a customer not being able to answer is easily understandable to the chef in this situation. The chefs often pose questions lacking clues; however, if a customer is not forthcoming with a response, a chef will promptly provide some hints.

These fragments show that something more is occurring than a customer simply stating what he or she wants. Through these interactions the customers present who they are. Some customers can give a concise answer, demonstrating themselves to be more or less experienced sushi customers, while others present uncertainty in their actions and required a provider's affirmation. After the drink orders, the customers and chefs move onto food orders. Although no space is available to report them, we see similar interactions, only more salient. That is to say, a brief question is asked without much clue as to an appropriate response. Some customers can answer concisely, others struggle, and some could not complete the order without making it clear that they did not understand the chefs' questions.

### *36.3.4 An Intersubjective Explanation of the Sushi Case*

We began with the puzzle of why sushi chefs make their service difficult and intimidating to customers and why customers still enjoy this service and pay for it. In the interactions above, we saw that the chefs ask a rather difficult question in a situation where there is no visible information to help the customers respond. The chefs then observe how the customers answer. Therefore, they are "testing" customers to see how experienced these patrons are. In more general terms, in trying to define themselves as valuable all services construct a certain culture. Sushi chefs define their service as sophisticated and esoteric when posing a difficult question to customers who are in the middle of seating themselves; they suggest that they offer sophisticated service for customers who are knowledgeable and competent enough to answer the question without visible or audible clues.

In turn, the customers cannot maintain safe distance from this sophisticated type of service. They need to demonstrate that they are sufficiently knowledgeable, skilled, and qualified to participate in the service. Thereby, the customers try to live up to the high standards and, to this end, often reach beyond their normal knowledge and skills. Customers are implicated in the service. When they are presented service as representing a certain value, their actions in response to the proposed value is part of the service. Therefore, it is understandable that customers participating in this sushi culture are expected to have a high level of applicable knowledge and a set of relevant skills. There is no clear separation between the customer and the service, and because the customer participates in the culture, where the customer stands within the culture becomes an issue.

In this situation intimidating customers is not an irrational act. Service providers need to push the customers, as these providers must prove that the service is valuable, i.e., something beyond the customer's knowledge and experience. The service is presented as being more sophisticated and of more value than any service the customers encounter in their daily lives. If service providers presented their services as being ordinary and mundane, then the customers would see this as simply engaging in everyday reality. Challenged in this manner, customers then present themselves in various ways. Some show that they are in fact not so knowledgeable,

and others show that they are. In either situation, they cannot simply answer the chef's questions by conveying what they want; they need to present their own selves.

This case of high sushi culture, although illustrative, begs further questions. Do all services need to intimidate customers? Or are these interactions only specific to sushi or similar kinds of upscale services? How about more ordinary services as opposed to the upscale category? We need to clarify how we can generally understand the current case. To this end, we will review how upscale services are organized in general and then discuss other kinds of services not in the upscale category.

## 36.4 Beyond the Sushi Case

### *36.4.1 Service Based on High-End Culture*

We can begin by describing the general patterns of highbrow, sophisticated services in general, such as upscale restaurants and luxury hotels. To illustrate this pattern, we can draw on several ideas of Pierre Bourdieu (1984), who more than any other theorist has elucidated the highbrow culture vis-à-vis the lowbrow. This discussion also helps look beyond the particular interactions at sushi bars above.

First, highbrow culture emphasizes formality as opposed to necessity. Bourdieu (1984, p. 6) wrote, "The antithesis between quantity and quality, substance and form, corresponds to the opposition-linked to different distances from necessity—between the taste of necessity, which favours the most 'filling' and most economical foods, and the taste of liberty—or luxury—which shifts the emphasis to the manner (of presenting, serving, eating etc.) and tends to use stylized forms to deny function." This taste of freedom is aristocratic and bourgeois value. The taste that emphasizes necessity is seen to be related to labor and lower classes of people who cannot help but investing in necessities (Bourdieu 1984; Veblen 1899). In contrast, people who try to present themselves as culturally sophisticated emphasize formality over necessity. They can show that they have the resources and time to invest in formality, something that does not necessarily give them any immediate practical return.

Therefore, many service organizations that lay claim to high value follow this logic of formality. For these businesses, the service should not be efficient and convenient; instead it must feature a number of elements that are not tied to necessity but related to aspects of formality. In upscale services, there are myriad rules and procedures that customers need to follow. French restaurants have table manners and wine tasting rituals. As noted above, sushi has a number of such manners and rituals. Eating sushi by hand is one such example. People try to provide rationale for that, e.g., sushi is so fragile that a gentle touch is required and in the past sushi was a fast-food type snack that people tossed into their mouths by hand. Yet, the point of these manners and rituals is the fact that they are the opposite of functional reasons.

Second, the highbrow culture requires individuals to have certain embodied competencies to produce practices of a particular style. Bourdieu (1984) called

such competencies inculcated in bodily “habitus”. Behaving elegantly and in a sophisticated manner is an important part of the culture. It is not easy to behave properly in sushi bars, French restaurants, and other upscale service locales. Not only is it difficult to elegantly eat sushi by hand, but also conversing with the chef in a manner proper to the setting is also no simple task. In a French restaurant, customers are required to have mastered the ritual of wine tasting and possess proper language to voice their opinions. Choosing cheese may also be difficult. At many restaurants, during the latter part of the meal, more than ten kinds of cheese are presented on a tray or cart. Without explanation of each one provided, customers are asked, “What would you like?” Being able to pick a few types of cheese that one prefers without any fuss—not to mention, knowing the names—is part of the qualification to be a customer in such an establishment. In general, upscale services are designed to be difficult for customers to understand and thus allow them to demonstrate refined skills.

Third, in addition to being able to produce practices in a harmonious manner, individuals also need to have embodied skills to appreciate subtle differences in flavor, style, and aesthetic. In fact, it is not just appreciating the differences among items, but preferring certain things to other choices is part of the process. Therefore, we often emphasize that people have proper “taste” (Bourdieu 1984). What people prefer in the highbrow culture appears to be ostentatious and even hollow in the eyes of those with popular taste.

In the postmodern age, defining tastes in highbrow culture has become more complex. As most services are aestheticized and made accessible to the mass population, people with high cultural skills tend to find luxurious things distasteful (Holt 1998). These people tend to prefer things that require much intrinsic effort to appreciate rather than something that can be paid for (Holt 2002). On the other hand, people in high culture often enjoy works of popular culture, resulting in what is often called the “omnivore” (Peterson 2005; Peterson and Kern 1996). This view does not show that taste classification has become meaningless; there is nothing in it that contradicts the Bourdieuian framework of cultural sophistication (Atkinson 2011; Prior 2011). By presenting their taste as distinguished and requiring special effort or knowledge, persons can claim a certain social status, which is Bourdieu’s central argument.

All this discussion may be summarized by the seemingly paradoxical statement; ‘the more expensive the service is, the less service one can receive.’ A higher price tends to mean an upscale and sophisticated service that emphasizes refined tastes. Such services tend to be less friendly, with the employees typically looking more professional than friendly. While employees in a lower end service are often instructed to smile and come across as friendly, professional employees dress immaculately and behave seriously but elegantly (Dion and Borraz 2017). High-end services tend to provide customers with less information. Comparison of the menus of high-end and lower-end restaurants revealed that the listings in high-end establishments are less informative and often feature esoteric wording with little explanation. Menus found in cheaper restaurants often provide information such as explanations; e.g., “slowly cooked in Bourgogne pinot noir”; recommendations,

e.g., "our signature dish" and "original"; and descriptions of a special aspect of the dish, e.g., "blue-fin tuna from Tsukiji". The menu at upscale French restaurants is difficult, often even for the French. When explicating the history of restaurants and particularly in the early days of restaurants, Spang (2000, pp. 185–186) wrote:

> The menu ostensibly listed a restaurant's offerings, but it did so in a language that few found especially informative. The affluent, educated, and Francophile travelers of the early 19th century did not often fret about their linguistic abilities, but even native speakers of French were not guaranteed to understand a menu.

Service in lower price categories often emphasizes rapid delivery whereas upscale services tend to be slower. While good service tends to mean expedience, expensive service, or at least service related to high culture, tends to be the opposite. Fast service appears vulgar and quotidian; sophisticated services represent leisure and spaciousness. Service employees should also behave graciously; hurried behavior implies lack of sophistication. Similarly, service employees should not be too friendly, as being overly gracious might indicate a lack of confidence. Rather, these providers should look professional and focus on service, not on customer evaluation.

### *36.4.2 Intersubjectivity in Popular Services*

Because the intersubjective framework suggests that any service, as long as value is co-created, entails intersubjective struggle, we can see many examples in casual, popular settings. Take the example of coffee shops, which tend to be accessible to the mass population. Here, menus often feature obscure or foreign names. Sizes of coffee begin with "short" and then "tall" instead of small, regular or large. After that, sizes may continue to Grande, Venti, and Enorme. These are not English words, and customers in the U.S. would traditionally not be familiar with them. Why would this business need, or want, to use words that customers do not know? The answer is precisely that these words should not be known to the customers. A known offering seems to be all too familiar and therefore carries no special value. Similarly, a casual Italian restaurant the author studied in Japan used Italian names such as Pizza Melanzane and Pizza Salsiccia Piccante. The restaurant even used quotation marks to list these names; that is to say, these are proper names that customers do not necessarily know. The data includes cases where customers struggled to pronounce these names; many customers instead pointed at the menu and said, "This." At another fast-food hamburger restaurant in Japan, the author also saw cases in which customers had trouble stating some of the menu items that were not straightforward. The company used these names to indicate that these selections are special. Therefore, even relatively reasonable services can entail intersubjective struggle. We need to understand that using obscure names involves the negation of customers because this act suggests that the service is more sophisticated than the world with which the customers are familiar.

On the other hand, it is true that there are many services that seek to minimize any struggle. For instance, if hospital service is organized to be difficult to understand or even intimidating, this would be a serious problem—in fact, many of them are problematic in this way. In general, hospitals need to be designed for accessibility. How can we reconcile this fact with the argument so far? The answer is that subjectivity and intersubjectivity are both relevant to any social setting, and for a hospital, the subjective value is important. That is to say, how a patient, the subject, views the service of the hospital, the object, has an important reality. The patient has a problem, e.g., illness that must be addressed, and does not need to implicate him or herself in this process. In this subjective framework, providers do not consider what kind of person this patient is; that is, what value this patient has vis-à-vis the value of the hospital. They only need to address the patient's problem.

Yet, even in the hospital setting we still need to consider intersubjectivity in terms of value co-creation. If the service context is jointly created by care providers and patients, the patients are inevitably implicated in the service to a certain extent. Therefore patients would try to show that they have a serious problem that needs more attention, and that they are considerate individuals who deserve more respect from physicians. Physicians understand that whatever they say and do is not simply an act of medical care but also affects the patient/doctor relationship. They need to both maintain authority in a consultation and show compassion to reassure patients. All these actions are in the intersubjective realm. How each person presents his or her own self is important for the service.

Therefore, any service is a mixture of subjective and intersubjective value (Helkkula et al. 2012). Even sushi bars have subjective value. Namely, the quality of sushi is critical for the customers who view the service from a distance. This is subjective because the customer (subject) is evaluating the sushi (object). In the next move, however, how this customer is related to and qualified for this valuable sushi experience becomes an issue, i.e., the intersubjective value. Customers try to show that they can discern subtle differences in taste and express opinions and responses in a way that exhibits their competence. Nonetheless, how the customer subjectively judges the objective sushi, e.g., whether it is tasty, is a significant issue.

While this discussion appears to uphold the assumption that subjective and intersubjective values are separable as different phenomena, subjective value is in fact inseparable from intersubjective value. The intersubjective presentation of self is not separated from a subjective judgment of what is offered objectively. The type of subjective judgment one makes has an intersubjective meaning to others in the situation. Sushi connoisseurs tend to value sushi that is subtle and novel, which ordinary customers tend to find strange. Bourdieu (1984) made it clear that taste differs depending on one's position in a social structure, and thus is important domain of intersubjective struggle where individuals try to prove their value. Subjective taste depends on intersubjective relations and vice versa. Therefore, no claim is made that the subjective value of the sushi is unimportant; it is suggested that the value rests on a complex entanglement of the different realms. We need to understand the mixture of these different realms of value for each service context.

Intersubjective value requires practices that are quite different from those required for subjective value. For example, in terms of the subjective value of having a medical issue addressed, a hospital must be designed to be accessible and shown to be caring. Yet, to demonstrate authority and high level of medical knowledge, physicians may surround themselves with medical texts and diplomas, speak using professional jargon, and keep a certain distance from patients. That is to say, accessibility and inaccessibility are both required in subjective and intersubjective value respectively.

## 36.5 Implications

### *36.5.1 The Intersubjective Perspective on Service*

We began with a puzzle in which one particular type of service appeared to contradict the existing wisdom on service; specifically, the service was organized so as to intimidate customers. The intersubjective perspective offers a new way to solve this puzzle. Typical explanations of service tend to separate the subject (actors) and the object (service); the actor or beneficiary subjectively judges the value of the service that is objectively posited. In this framework, intimidating customers makes little sense. In contrast, as we have seen both theoretically and empirically, the intersubjective perspective allows us to understand that the act of intimidating customers can be a reasonable strategy because service, as long as it is about value co-creation, involves some degree of negation of the actors in an interaction. Here, many customers then try to prove themselves by showing their competence. Others, being less confident customers, present a more moderate and humble self. Either way, presentation of self is part of service. We have also seen that even if intimidation is not observable in some services, service in general, including those not in the upscale category, encompasses some elements of negation and thereby the intersubjective struggle.

Thus, we can now examine some core concepts of S-D logic from the intersubjective perspective. S-D logic researchers have emphasized the interactional and intersubjective nature of value co-creation (Ballantyne and Varey 2006; Edvardsson et al. 2010; Helkkula et al. 2012; Löbler 2011), which cannot be reduced to particular characteristics within each individual. In these interactions, then all actors are implicated and implicate others in the service (Peñaloza and Venkatesh 2006). From this perspective, we will discuss concepts of value and resources. The discussion remains within the general promise of S-D logic, which is founded on the intersubjective orientation (Löbler 2011), and strengthens this theoretical foundation.

First, how can we consider value from the intersubjective perspective? Service involves not only the value to a beneficiary but also the value of the beneficiary. Once again, this dual nature arises because each actor is an inseparable part of the service. When an actor considers the value of a service, she is considering the value

of herself who is part of the service. She needs to present herself as valuable, for instance, as knowledgeable, experienced, and qualified. It is rather obvious that the service provider's value is inherently tied to the value of the service. A competent chef creates valuable service, and thus the identity of the chef is inseparable from the service. In a subtler manner, the value of the customers is part of the value of the service in the sense that they seek to define themselves as valuable vis-à-vis the service in which they are implicated.

Therefore, the study results overlap with the observation of Helkkula et al. (Helkkula et al. 2012, p. 3) in that "it appears that even if service customers individually experience value, they also tend to share certain type/types of experience/experiences with other service customers, that is, the data are intrasubjective and intersubjective." Yet, one more distinction is necessary to clarify the intersubjective nature of value: Value is intersubjective not only because multiple customers "share" the same type of experience but also because the customers are implicated in the value. One's subjective judgment of value is an intersubjective act and therefore involves the presentation of one's self. This more radical intersubjectivity helps bridge the individual and social value. The value is social not simply because we are drinking the same bottle of wine and our experiences coincide. It is social because value is an interactional issue; when one person says, "I like the notes of spicy oak" and another returns, "I don't think so; I think it is too much, but I do like the crisp finish," the value judged is intersubjectively presented. The value here implicates the actors themselves, e.g., their competence, experience, knowledge and skills as they present and negotiate their selves. This creation of value occurs even when participants do not explicitly talk. When an individual tastes the wine in isolation, he is referring not only to the wine but also to himself: "Who am I that I can taste this wine in this way? Can others react in the same way?"

The service could still be valuable if customers' problems are fixed and specific requirements are fulfilled. Such values are, however, more or less predefined; customers had a problem to fix or requirement to fulfill prior to the service and not so much as a result of co-creation. To address such problems or requirements, actors still need to integrate various resources in collaboration with various other actors. Nonetheless, to fully appreciate the co-creative nature of value, we should not reduce value to individual characteristics, such as a problem or a requirement that one person has, but rather examine what happens between individuals—intersubjectivity. When a problem is solved or a requirement is fulfilled through interactions, the actors in these situations present and negotiate their selves.

Second, the concept of resource must be discussed. There is some ambiguity in the S-D logic literature as to the relationship between resources and actors. On one hand, scholars suggest that actors "have," "use" and "apply" resources (e.g., Vargo and Lusch 2004, 2016). On the other hand, scholars have also written that "The customer is primarily an *operant resource*" (Vargo and Lusch 2004, p. 7) and that "actors themselves as resources within a particular context" (Chandler and Vargo 2011, p. 38). Are resources *objects*—whether tangible or not—that actors possess, apply, and integrate? Or are resources *subjects* that act and constitute the network in

which service is achieved? The intersubjective framework is useful in helping us answer these questions.

There is nothing wrong in suggesting that humans "have" or "possess" operant resources, namely knowledge and skills. Yet, from the intersubjective standpoint, possession is an act that is meaningful in relation to others. Certainly, experienced sushi customers have extensive knowledge of fish, vinegar, and rice, as well as skills for distinguishing subtle flavors and textures. These operant resources are inseparable from who these customers are. Possessing these elaborate resources constitutes their identity, namely sushi connoisseurs. Perhaps, the verb "to possess" may not be the right word to talk about operant resources (Cook and Brown 1999), as actors perform the resources and this performance is also theatrical in Goffman's (1959) sense.

This intersubjective view is in line with Vargo and Lusch (2004, p. 2), who clearly stated this idea, "resources *are* not; they *become*" (emphasis in original; see also, Zimmermann 1951). The construction of context performatively brings a resource into existence; "resources 'become' resources largely as a function of the contexts in which they are embedded" (Chandler and Vargo 2011, p. 39), an idea that can be developed more thoroughly through the concept of intersubjectivity. Here we can add that this becoming of an objective resource involves the becoming of a subjective one. When an actor makes one resource relevant, the actor presents her own self and thereby constructs and transforms her identity. In the case of sushi culture, the fact that a customer has mastered and thereby performs the proscribed knowledge and skills better than a chef would expect implies how she can present and negotiate her own self as a customer. Through this intersubjective presentation and negotiation by means of her use of resources, she *becomes* a certain customer.

In this sense, actors are not inputs to service in that they have requirements fulfilled through the service. Rather, they are outcomes of the service. They *are* not; they *become*. Service should be considered as a process through which actors become that which they have not been before. Of course, it is not meant that the individuals' previous existence is trivial, or that completely new individuals emerge out of service. The point is simply that the individuals cannot be separated from the service. When service is jointly achieved and value is co-created, individuals are also co-created. Just as service is not created in a vacuum and is always constructed by utilizing available resources, individuals are also so constructed.

Although this chapter began by trying to solve the puzzle seen in service at sushi bars and then, to this end, examined cases of customer-provider interaction, the theoretical ideas discussed are not limited to dyadic or direct face-to-face interactions. It is a practical strategy to focus on interactions of a small group so that we can keep the analysis manageable. Yet, the theoretical implications drawn from this analysis are discussed with broader interactions in mind. Even when actors do not directly interact, as long as value is co-created and subjects are implicated in the objects, their selves are presented and negotiated. Servicescapes are designed carefully to present the type of service proposed. This is part of the presentation. When we walk into a luxurious hotel, a professionally equipped medical facility, or an elegantly furnished meeting room in a law firm, we feel we need to behave in a

certain way and thereby present certain selves, even without direct interactions with others. Similarly, presented with some tangible goods—appliances—people are in indirect interaction. Again, in many restaurants chefs are working in the kitchen and typically do not directly interact with customers. Nonetheless, the chef still seeks to impress customers, and the customers demonstrate that they can appreciate the subtlety. This is also the case between a viewer and the filmmakers when people watch a film at home or between a learner and an instructor in the case of a Massive Open Online Course (MOOC) on a computer.

### *36.5.2 Decentering Service Systems*

Service science has emphasized the relational nature of service systems. The definition of service systems recursively includes other service systems; Spohrer, Maglio, Bailey, and Gruhl (2007, p. 72) wrote:

> More precisely, we define a service system as a value-coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws). This recursive service system definition highlights the fact that service systems have internal structure (intraentity services) and external structure (interentity services) in which participants coproduce value directly or indirectly with other service systems.

Service systems are inherently open and defined by their relations with other internal and external service systems. This recursive definition needs to be taken literally; we should not think that service systems exist first and then become connected with each other, in which case no recursion would be necessary. Each connection that a service system makes with another service system alters what the service system is; hence, the definition of this system includes other service systems. We need to decenter service systems and cease to see them as independent and firm subjects that lay underneath service. Instead, we should inquire into how service systems define themselves by tracing the connections that they make (see also, Latour 2007).

Furthermore, service systems are not defined externally. They define themselves. Service systems are seen to be constantly trying to define themselves by creating connections with other service systems. To define itself, a service system makes use of various distinctions vis-à-vis other systems and therefore definition is always relational. Self-definition through altering the connections inevitably alters the other service systems. This also means that value changes as systems connect to other systems. Nonetheless, it is important to keep in mind that these self-definitions are not subjective acts; definitions are joint achievements. One’s presentation may be accepted, challenged, ignored, or suspended by others.

### 36.5.3 Implications for Practice

Practitioners need to take intersubjective struggle seriously. As we have seen throughout this chapter, services designed and practiced based solely on the subjectivist point of view miss an important aspect of value co-creation. If we make service accessible and easy, we should be aware that this choice of action, which could be a viable strategy to improve many services that are poorly designed, would have an intersubjective meaning and alter the relationship between actors, e.g., a service provider becoming slightly subservient to a customer. In service, satisfying a customer is a tricky issue. The fact that customers as well as other actors need to be negated to some degree should not be taken lightly as mere theoretical rhetoric. We need to consider the option of rendering the service more difficult for customers, at least in some respects. How we do this depends on the category of service. For a service targeting elite customers, we could render the service largely difficult and esoteric and also design the service to carry an element of tension. For a more casual service, we need to keep the service accessible and comfortable for the general population while implementing some parts of negation, e.g., Italian words used in coffee shops and a non-quotidian atmosphere.

It is obviously wrong to simply challenge customers for no reason. The key is to consider what actors, particularly customers, strive to become through the service. As long as these customers have not yet achieved what they want to be, the customers are then to be negated. This approach is markedly different from trying to understand what customers want. Of course, this by no means implies that we should ignore what customers want; it only suggests that the dialectical struggle has revealed the contradiction in such a move. That is, to address what the customers want may work against them. It would be overly idiosyncratic to suggest that customers want to be negated and tested while paying an expensive bill. It is more realistic to suggest that customers are facing a dialectic struggle and cannot be unilaterally satisfied.

Negating customers is a risky move. If negation is thorough, this kind of service may not appeal to everyone and some customers may be put off. This course of action could reduce business at the expense of obtaining a smaller but core group of customers that seriously but critically appreciate the service. Furthermore, service providers who test customers can also be tested by customers with a high level of knowledge, experience and skills. Service can be contentious both for customers and for service providers. For these reasons, it is more comforting to try to fulfill customers' requirements or solve customers' problems. Negating customers, at least in some aspects, requires service professionals to be confident. It would make no sense to superficially imitate the style and patterns of interaction. Intersubjectivity implies that all the participants should implicate themselves in the service and thereby take risks.

## 36.6 Conclusion

This chapter explored the notion of intersubjectivity in general and dialectical struggle in particular by drawing on service-dominant logic, which decenters the traditional categories of firms and consumers and emphasizes the interactions through which actors co-create value. As long as service is value co-creation, with multiple actors working together, service is intersubjective. Therefore as service is an intersubjective phenomenon, actors are implicated in the setting and cannot separate themselves as subjects from the object. The participants need to present who they are. The value of service encompasses the value of involved parties. Struggle is an inevitable consequence of value co-creation. This fresh theoretical orientation advances S-D logic in the direction of its fundamental premise.

The discussion illustrated that intersubjective struggle is not peculiar to sushi service but applicable to higher class service in general. Furthermore, it has been shown that even popular services demonstrate some aspects of struggle, such as businesses using obscure names or creating a refined atmosphere that customers feel they should make an effort to match. On the other hand, it is also too simplistic to suggest that service should negate customers and only seek to create situations that are difficult to navigate. The basic question is what customers become, and service should create a culture that embodies an answer to this question. If this is done, the service will present culture that is somewhat unfamiliar to the customers and thereby negates them and lets them struggle to present their selves.

Finally, if we are to emphasize intersubjectivity, we need to decenter all service elements. Individuals and service systems are achieved results of service, not its inputs. While service science has emphasized "humans" that are part of the system (Spohrer and Maglio 2010; Schneider and Bowen 2010), this does not necessarily mean that we need to be human-centric in a sense that we should cater to what humans want and need. If we treat humans and human agency properly, we need to acknowledge that these individuals need not be unilaterally satisfied, but they are to be recognized. Who they are matters in service. In the end, the concept of human should not be decided upon prior to service science; it must be its achievement.

Although this chapter has tried to keep the theoretical discussion sufficiently general as to be applicable to various kinds of service, it has predominantly used examples of personal services, particularly restaurants. Empirical investigations are clearly needed in other service contexts such as hospitals, transportation, education, and entertainment. In particular, the relationship between what have been characterized as subjective and intersubjective values needs further clarification. Although these are theoretically inseparable, how participants deal with these values in actual service practice needs careful analysis. Furthermore, S-D logic is critical of restricting the concept of service to traditional service businesses and places service at the foundation of any economic exchange, including non-service sectors. Still, as long as value is co-created, any service, namely the application of specialized knowledge and skills for the benefit of another actor or the actor him/herself, should be intersubjective. Yet, we still need to consider the relationship between

intersubjectivity and value co-creation in cases where an individual uses products on his or her own. These situations that require and co-create value-in-context require further clarification that should be based on empirical analyses.

**Acknowledgements** This work was supported by JSPS KAKENHI Grant Numbers JP17K03875, JP15KK0086.

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